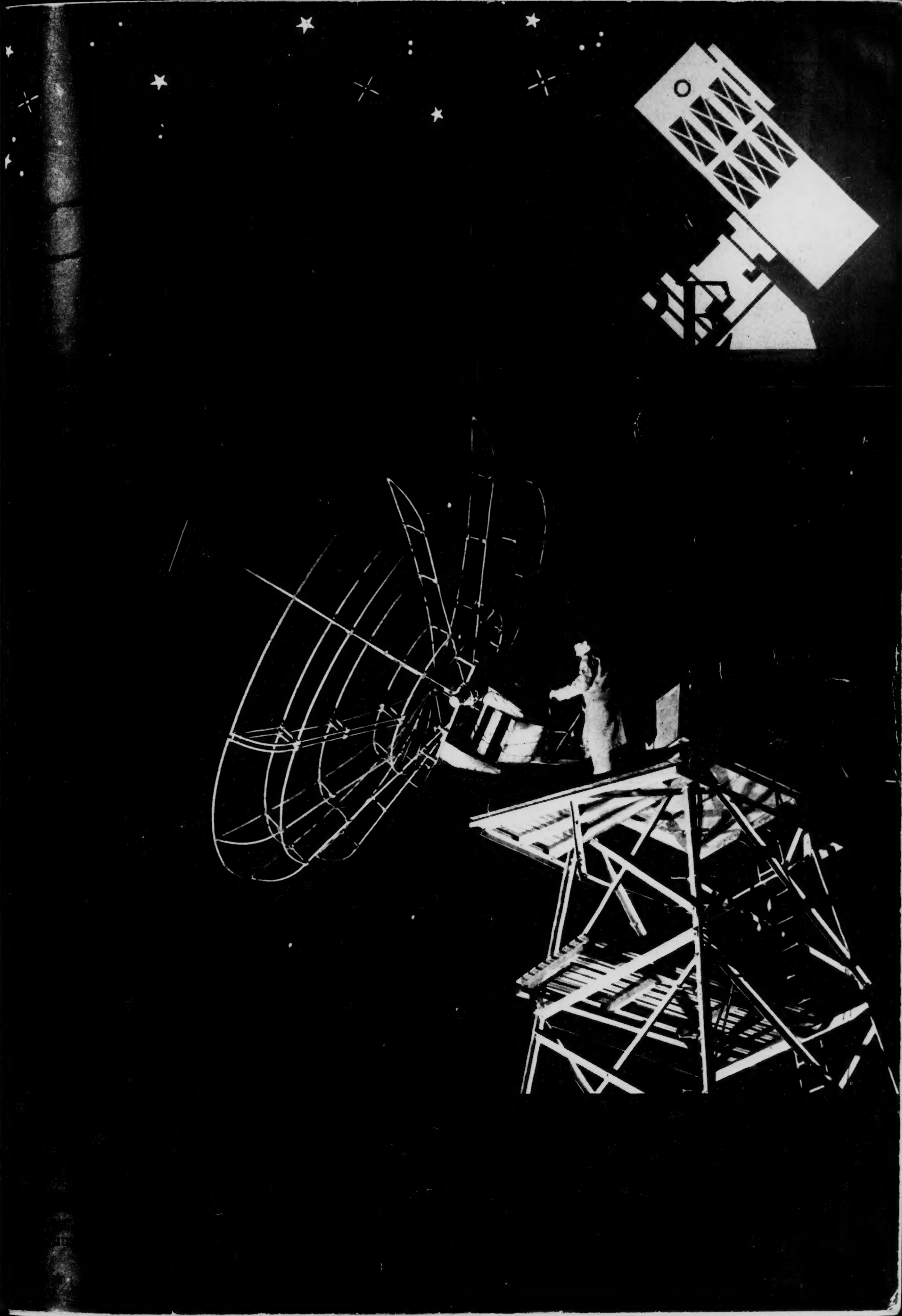


SKY AND TELESCOPE

Copyright, 1952, by
SKY PUBLISHING CORPORATION

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

ATTACK ON THE THIRD DIMENSION*

By WILLY LEY

IT WAS for symbolic reasons that Columbus Day was chosen for the dates of the First and Second Symposiums on Space Travel held at the Hayden Planetarium. I said last year that Columbus, when he set out on his trip to the West, had the wrong conception about the size of the earth—that he landed on the wrong continent—that he did not know the distance he had to sail nor how long it would take to sail this distance—that he had no idea about the nature of the continent where he finally made his landfall.

We can compare his situation with that in which the proponents of space travel find themselves now, on the 460th anniversary of that landfall. We are now thinking of reaching and exploring the moon, and compared to Columbus we simply know "all about it." I wish to emphasize, however, that I put quotation marks around this "all about it." When we calculate a spaceship flight track to the moon we know that it will end in the place where the moon will be when the presumed spaceship reaches it and that it will not lead us elsewhere. Once such a flight track has been calculated, we also know with great precision where the spaceship would be after, say, 10 hours of elapsed time. We know how fast it would move at that instant and we can devise ways and means of checking whether the actual flight track lives up to calculation or not. Of course, we know the distance and size of our goal, and even though nobody has been there yet, our astronomers have very definite ideas about the nature of the moon and the conditions we would encounter on its surface. Moreover, these ideas are very likely to be correct and are apt to find mostly verification rather than revision when we actually get there. In many respects we are immeasurably better equipped for a trip into space than Columbus was for his trip across the Atlantic, except for that one point that he had a ship that could make the trip and we do not.

The difference between a trip into space and all other trips which man ever made is that all the earlier trips were essentially two-dimensional, while a trip into space would be essentially along the third dimension. Even airplanes are, for practical purposes, tied to the two dimensions of the flat map, for a flight altitude of four or even eight miles counts little when compared to the 7,900-mile diameter of our globe. The older trips were West and South or a combination of the two, but when it comes to space travel the paramount dimension is the length of the radius vector. Where earlier forms of travel had the firm support of the ground, of the seas, or of the airflow around wings, the spaceship is supported, in a manner of speaking, by its cut-off velocity and its inertia, and the helping or opposing forces are not winds or currents but gravitational fields.

But I think it can also be said that we know better right now what is required of a spaceship, even though none has been built, than the shipbuilders of Columbus' day knew what makes a ship seaworthy. I said last year that Columbus had ships that could make the trip. I have to add that these ships were then a recent development. The ships of Roman times, a thousand years before Columbus, had to hug the shores just as closely as airplanes stay near the ground nowadays. It is possible that a Phoenician ship was occasionally blown across the Atlantic passively on a one-way trip. But a ship that could make the trip at will, and in both directions, did not exist until later. In short, Columbus specifically and people generally began crossing the ocean just as soon as they had ships for doing so. In that respect the proponents of space travel of our time and the seafaring men of the early 15th century find themselves in rather similar conditions. The will to go out into space exists, and the machine for doing so is in the state of being shaped.

I do not need to elaborate on the historical fact that five centuries ago there were also people who insisted that it couldn't be done and that it was dangerous besides. Nobody, to my knowledge, ever said that space travel would be easy. But more and more people, after having studied the problem, say that it can be done.

*From a talk given at the Second Symposium on Space Travel at the Hayden Planetarium, American Museum of Natural History, October 13, 1952.

VOL. XII, No. 3
WHOLE NUMBER 135

JANUARY, 1953

CONTENTS

COVER: A nighttime view of a 5-meter diameter parabolic antenna, which is used by J. G. Bolton (seen in the photograph) at Dover Heights, near Sydney, Australia, for the study of discrete sources of cosmic radio waves. The star background includes the Southern Cross, in the space between the reflector and the tower. The photograph was made with a Rolliecord camera, f/3.5 Xenar lens, and Super-XX film. The stars were photographed with an exposure of 45 seconds at f/4, with the camera focused at infinity. The focus was then advanced for the antenna, which was taken at f/11 using a flash. Photograph by Ken Nash. (See page 59.)

BACK COVER: The globular cluster M3, NGC 5272, in Canes Venatici, photographed with the 200-inch Hale telescope, three times enlargement. Mount Wilson and Palomar Observatories photograph. (See page 63.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Secton 538, Postal Laws and Regulations.

Subscriptions: $4.00 per year in the United States and possessions, and to Latin-American countries; $7.00 for two years. Add $1.00 per year for Canada and for all other foreign countries, making the total subscription $5.00 per year and $9.00 for two years. Canadian and foreign remittances should be made in United States currency. Single copies, 35 cents, foreign 45 cents. Circulation staff: Betty G. Dodd, manager; Nancy R. Bolton; Virginia K. Cox.

All notices of change of address must be sent one month in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts.

An array of 32 parabolic reflectors beside the Potts Hill Reservoir, near Sydney, Australia, which is used as a multiple-beam interferometer for studying the distribution of radio brightness across the sun's disk at a wave length of 21 centimeters. The commonly used simple interferometer cannot operate when there is more than one bright source upon the sun at the same time. With a total length of 713 feet, the resolution of this array is about a minute of arc. Photographs with this article are by CSIRO, Australia.

Radio Astronomy at the URSI Assembly

BY F. J. KERR, *Radiophysics Laboratory*

Commonwealth Scientific and Industrial Research Organization, Sydney, Australia

A HIGH PROPORTION of the world's radio astronomers were in Sydney during August, 1952, for the tenth general assembly of the Union Radio-Scientifique Internationale. The sessions and discussions at this assembly provided a very good review of the present status of radio astronomy.

URSI, which is one of the 10 international scientific unions, meets every two years. Previous postwar assemblies were held at Stockholm, in 1948, and Zurich, in 1950. This year's assembly was a notable occasion for Australian science, as this is the first time *any* of the international unions has met outside Europe or the United States. In spite of the long distances involved, 63 delegates from 13 overseas countries attended, in addition to the Australian workers. This large and representative gathering ensured a very successful meeting.

For most of the delegates this was their first visit to the Southern Hemisphere. Interested groups could often be seen pointing out to each other the Southern Cross and the Magellanic Clouds, and admiring the galactic center passing overhead. Most of the visitors came by air, and so had the experience of going from summer to winter in a few days, as well as changing their local time by as much as nine or 10 hours or more.

The work of URSI is carried out by seven commissions, one of which deals with radio astronomy. Four sessions were held by this commission, in the form of symposia on the following subjects: the sun, dynamics of ionized media, interstellar gas, and discrete sources. Under these headings a large range of topics was discussed. It will only be possible in this account to outline a few of the major contributions.

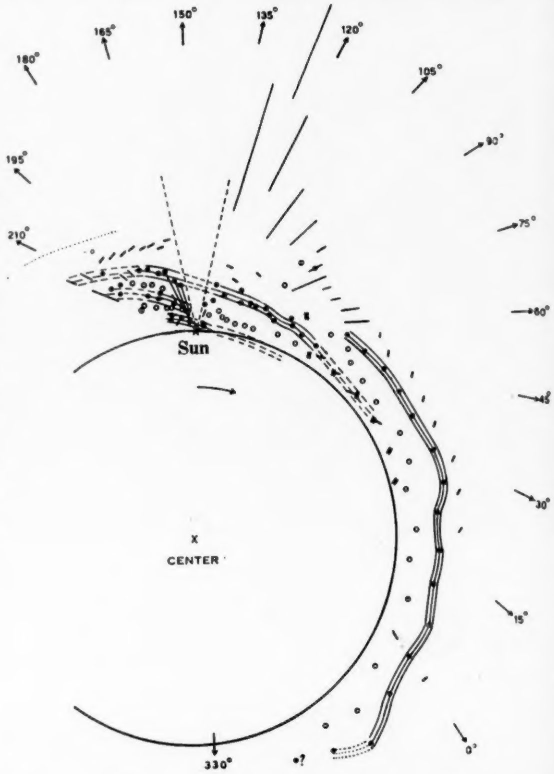
In the period since the 1950 meeting, a new branch of radio astronomy has been opened up by the discovery of the 21-cm. line radiation from interstellar hydrogen. (See the article by Otto Struve, *Sky and Telescope*, July, 1952.) This is the first line radiation that has been observed in radio astronomy; because it has a definite wave length, it gives for the first time the possibility of measuring Doppler shifts and hence the radial velocities of the source regions. Also, it has not hitherto been possible to observe directly, either by optical or radio means, the neutral hydrogen which abounds in interstellar space. The session on the interstellar gas, of which Professor Jan Schilt, Columbia University, was chairman, was opened by Harold I. Ewen, of Harvard. Dr. Ewen described the circumstances leading to his original discovery of the line in 1951, and outlined the difficult experimental techniques which are involved in detecting the very weak radiation. He obtained the first measurements of the intensity and line profile, and also the spread in galactic latitude, but was restricted to observations along a single declination, through using a fixed antenna.

W. N. Christiansen, of the Radiophysics Laboratory, Sydney, then described the first survey of this radiation over the sky. This survey, which was made in collaboration with J. V. Hindman late in 1951, was of a preliminary character, but yielded the general distribution of the radiation over the sky. It was found to be largely concentrated in a narrow region around the galactic plane, with intensity variations arising from irregularities in the gas distribution, and from the line-broadening effect of galactic rotation. The survey also showed that the 21-cm. line is sometimes double. In such a case the received radiation is almost certainly coming from two masses of gas that are at different distances and that consequently exhibit different radial velocities as a result of galactic rotation. The double form of the line was found to extend over a full quadrant of galac-

tic longitude (from the anticenter to Carina), suggesting that the observed radiation was originating in two large spiral arms of the galaxy. The preliminary measurements were not sufficiently precise, however, for the shape of the arms to be delineated.

In recent months more refined observations have been made by the Dutch group; these were described by C. A. Muller. A series of careful tracings of line profiles is being made around the accessible parts of the galactic equator. Multiple lines, with two, three, or even more peaks, have been found to occur commonly in the galactic plane. Each peak is considered to arise from a separate large condensation. On this basis, good progress has been made in sketching out some of the main structural features of the galaxy. To do this, the distance of each radiating region must be deduced from the line profile. This can be done, on the assumption that galactic rotation is the main cause of frequency displacement. In each direction, the radial velocity due to galactic rotation varies with distance from the observer, so that the frequency scale can be interpreted as a distance scale. J. H. Oort's model of the galaxy was used.

A series of such derivations, measured with a 7½-meter parabolic reflector at Kootwijk, Netherlands, led to the results shown in the accompanying chart, which was kindly furnished by Dr. Oort in November, 1952. It represents the galactic plane, observations having been made at points on the galactic equator spaced five degrees in longitude. The dots refer to principal maxima in the density of hydrogen, open circles to minima. Short lines perpendicular to the radius vector from the sun indicate points where the intensity is half that in the maxima, while the dotted line between 180° and 215° longitude shows where the density drops to zero. Lines in the direction of the radius vector indicate secondary maxima or "shoulders" in the line profiles.

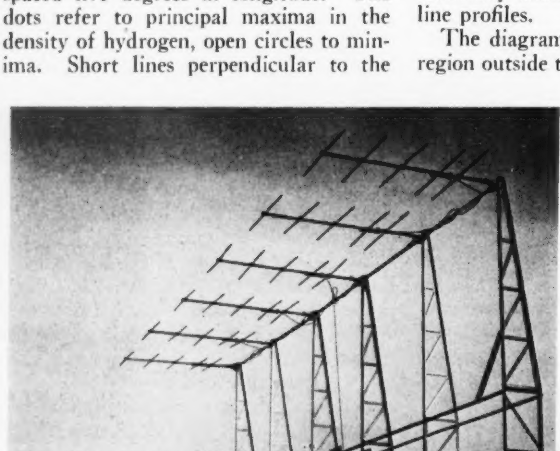


Spiral arms in the outer parts of the galactic system, as derived from observations of the 21-cm. hydrogen line emitted by interstellar clouds, by C. A. Muller, H. C. van de Hulst, and J. H. Oort. A large portion of a spiral arm appears farther out than the sun from the center; the arm is oriented in the direction of a trailing arm. A noticeable discontinuity occurs near galactic longitude 50°. Leiden Observatory diagram.

The diagram refers exclusively to the region outside the large circle around the center and passing through the sun. The sun's distance from the center was assumed to be 9.4 kiloparsecs. The analysis of the parts of the line contours that correspond to the inner parts of the galaxy is considerably more difficult and is still in progress. The regions of longitudes 135°-160° and 315°-340° are unobservable because of the smallness of the differential rotation in these directions; the sector between 220° and 320° does not rise above the horizon in the Netherlands.

Several groups are now working on the 21-cm. line, and further observations of this type should produce a considerable amount of information on the detailed structure of the galaxy.

Now consider the general continuum of the radio spectrum. The session on "discrete sources of cosmic radiation" showed that considerable progress has been made in this field in the last two years. A large body of new observational evidence has been collected on the properties of sources, many new objects and even new types of object have been discovered, and progress has been made in the identification of radio sources with astronomical objects.



An array of 12 Yagi antennas at Dover Heights, near Sydney. This array, whose beam is directed horizontally, is used as a sea interferometer for the study of discrete sources of cosmic radio waves. The wave length is three meters.

General agreement has been reached that the fluctuations of source intensity all arise in the terrestrial ionosphere. A long series of observations at the Cavendish Laboratory, Cambridge, England, has yielded no evidence of any intrinsic variations in the sources themselves. Position finding has improved to the stage where the positions obtained by

different observers agree closely for the stronger sources. There is still considerable disagreement, however, as to the positions and in some cases even the existence of the weaker sources. In establishing the existence of a weak object, it is generally necessary to distinguish among the effects of several sources which are in the antenna beam at the same time. Different types of antenna systems are used by the various observers, and these may lead to different interpretations of such multiple effects. Various measurements have been made of the spectra of sources, but here there is some disagreement, arising from the difficulty of making absolute intensity calibrations of equipment operating at different wave lengths. Observations of discrete sources now extend over the range from 25 centimeters to 16.4 meters.

The most interesting discussion concerned the angular size of discrete sources. Astronomers may need reminding at this point that, while a radio telescope is an extremely sensitive instrument, its angular resolution is poor compared with that of an optical telescope. This is a consequence of the much greater wave length. A resolution of the order of minutes of arc can only be obtained by refined interferometry.

B.Y. Mills, of the Radiophysics Laboratory, gave a progress report on an attempt to determine the angular sizes of several of the stronger sources. An interferometer has been set up at a wave length of three meters, with long base lines, using a radio link between the two antennas. Preliminary measurements have been made with a base line of 10 kilometers. These indicate that all the stronger sources have a size of at least one minute of arc, the strong source in Cygnus being approximately this value. Some further equipment checks are, however, required before these conclusions can be regarded as firmly established.

F. G. Smith, of the Cavendish Laboratory, Cambridge, gave some results obtained with a three-antenna interferometer with variable spacing. He has obtained for the Cassiopeia source a value of several minutes of arc, the order of size of the object, centered on the radio position, which has been discovered on a recent Mount Palomar photograph. Measurements on the Cygnus source suggest that it too has a finite angular size.

R. Hanbury Brown, of Manchester, England, has also developed equipment for measuring source size. This uses a new principle, in which the low-frequency "noise" outputs from two widely spaced receivers are correlated, rather than the phases of the radio-frequency radiation received by the two antennas, as in the normal interferometer. With this method, it is possible to use much greater separations between antennas, as it evades the difficult problem of transmitting the radio-frequency phase over a long distance.

Radio astronomers at the URSI assembly at Sydney, Australia, in August, 1952. Those whose countries are not mentioned are from the Radiophysics Laboratory, CSIRO. 1, W. N. Christiansen; 2, F. G. Smith, England; 3, J. P. Wild; 4, C. S. Higgins; 5, B. Y. Mills; 6, J. H. Piddington; 7, J. P. Hagen, U.S.A.; 8, J. L. Steinberg, France; 9, S. F. Smerd; 10, J. V. Hindman; 11, E. R. Hill; 12, C. A. Shain; 13, H. I. Ewen, U.S.A.; 14, F. J. Kerr; 15, R. Hanbury Brown, England; 16, L. W. Davies; 17, Miss R. Payne-Scott; 18, C. A. Muller, Netherlands; 19, A. G. Little; 20, M. Laffineur, France; 21, O. B. Slee; 22, J. G. Bolton. Dr. J. L. Pawsey, leader of the Sydney radio astronomy group, was absent when the picture was taken.

J. G. Bolton, of Sydney, described an investigation with a combination of a vertical and horizontal interferometer, the latter with a relatively small antenna separation. This work has demonstrated the existence of a new type of extended object of larger size than those observable with wider-spaced interferometers. The fringe patterns obtained are in fact very complicated, indicating the existence of a large number of such objects, with diameters of the order of a few degrees, and altogether covering most of the sky. At least 29 of these extended sources have been recognized. In some cases, it has been possible to derive the brightness distribution across the object by varying the antenna spacing, and by observing the source as it rises over the sea. The strong "point" source in Centaurus, for example, appears now to be a disklike object with a diameter of several degrees, with an intense central condensation of small size.

Smith also reported the discovery of an extended object. At galactic longitude 353°, he finds a narrow peak, about three degrees wide, on top of the broader maximum which follows the galactic equator. He suggested that this "bright streak" might be due to ionized hydrogen, whose galactic distribution might well be different from that of the main source of the background radiation. If so, the "streak" should extend right around the galactic equator, but other observers, working at different longitudes, have not found any such continuous object.

These extended sources have all been found by interferometry, with relatively small antennas. Hanbury Brown reported some results obtained in a different way. He has made a detailed plot of the intensity over the narrow strip of sky (30 degrees wide in declination) that can be reached with the 220-foot antenna at Manchester. This plot shows a considerable degree of fine structure in the contours, presumably representing the effects of extended objects of some kind.

Summarizing the results on source size, there is no evidence yet that any of the known objects are stellar in character, but some are definitely nebulous. The tentative result as reported by Mills suggests even that all the objects may be of sizes greater than one minute. In consequence of these new results, the former term *radio stars* is now falling into disuse, in favor of the more general phrase, *discrete sources*.

Some new individual identifications have been made by various workers. These may be separated into three broad types. The first consists of unusual galactic objects. The Crab nebula (the remnant of a supernova explosion) has been known as a radio source for some years. Hanbury Brown has now added Tycho Brahe's supernova. (Mills also has a source near Kepler's supernova, but the association is in this case rather

doubtful.) The diffuse object in Cassiopeia has already been mentioned. A somewhat similar object in Puppis has also been found at Mount Palomar, in the position of one of Bolton's extended sources. This object has a diameter of about one degree, with many small bright patches, and large differential radial velocities.

The second group contains a number of unusual extragalactic objects. The strong source in Cygnus may be associated with an object which Baade interprets as two galaxies in collision. In addition, M87, which has been identified with a source in Virgo, may be an example of a partial collision. Another source may possibly be identified with NGC 1275. Bolton pointed out that all the objects in these two groups are characterized by very large differential velocities.

The third group consists of relatively nearby galaxies. Radio-frequency radiation has been identified from a number of the closer systems, including the Andromeda nebula, by the Manchester and Cambridge groups.

The majority of the observed objects, however, remain unidentified. It is commonly considered that the general background of radiation over the sky, on which the discrete sources are superimposed, is due to the integrated effect of a very large number of unresolved discrete sources, at least at the longer wave lengths. The discussion in Sydney drew attention to the paradox that the individual identifications which have so far been made are all with unusual objects, whereas the background distribution suggests that common objects are responsible.

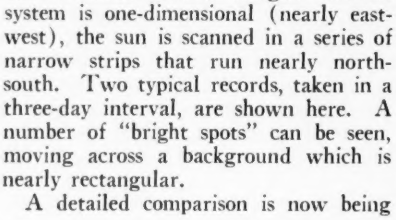
J. H. Piddington, of the Radiophysics Laboratory, discussed the origin of the background radiation, using the observational data at all wave lengths. The results are best fitted by a model in which the short wave length radiation comes from clouds of interstellar gas, and long wave length radiation from the discrete sources, with the interstellar gas now acting as an absorber. The physical properties of the gas clouds can then be deduced from the data. It was suggested, however, that the observational results may not yet be good enough for quantitative reasoning of this kind.

The session on the sun was mainly concerned with the distribution of intensity over the solar disk. In the case of the quiet sun, the observed intensity distribution can be used to derive a model of the solar atmosphere, and for the disturbed sun the active regions can be localized on the disk. A simple interferometer, with a sinusoidal system of fringes, is well suited for the determination of the position of a single active region. It is unsuitable when several active regions are on the sun at once, or when a continuous distribution is being studied.

An important new development in this field was described by W. N. Christiansen, of Sydney. His equipment, which is an analogue of the optical multiple-beam interferometer, uses an array of 32 parabolic reflectors, each six feet in diameter and spread out over a line 713 feet long. This system produces a series of well-separated narrow fringes. Operating at a wave length of 21 centimeters, the fringes have a width of three minutes of arc and are 90 minutes apart. Thus the intensity distribution over the sun's disk is traced out as the sun drifts across each of these narrow fringes. As the system is one-dimensional (nearly east-west), the sun is scanned in a series of narrow strips that run nearly north-south. Two typical records, taken in a three-day interval, are shown here. A number of "bright spots" can be seen, moving across a background which is nearly rectangular.

A 25-square-meter parabolic antenna at Potts Hill, near Sydney, used for some years in continuous automatic recording of solar radio intensity at 25 and 50 centimeters. It was also used in 1951 by W. N. Christiansen and J. V. Hindman for a preliminary survey of the 21-cm. hydrogen line radiation.

A detailed comparison is now being made between radio bright spots and visible features on the sun. The bright spots are closely related to visible sunspots, but are in general found farther out from the central meridian than the corresponding spots. One case has been observed where a radio spot lasted about one solar rotation longer than the associated visible spot. Study of an extended series of records provides strong evidence for a base level, corresponding to the quiet sun. There is clearly a considerable amount of limb brightening at this wave length, but it has not been possible to fit the observed results with a solar model which assumes radial symmetry. So far, two series of daily records have been examined in periods three months apart. A substantial change in the apparent diameter of the sun was noticed between the two series. The mean position angle of the scanning line relative to the sun's equator changed by 30° in the interval. Thus the observed effect may indicate that the "radio sun" is elliptical in shape. However, it is still possible that the sun might have altered in apparent size between the two series. Perhaps the question will not be resolved until the completion of a second interferometer, to be built in the perpendicular direction.



Typical intensity records obtained by W. N. Christiansen, with the sun passing through one fringe of his 32-element interferometer (pictured on page 59). The dates are June 26 and 29, 1952. The movement of active regions across the sun is clearly shown. The vertical lines represent the limits of the sun's optical disk.

Dr. Smith reported some further work using the technique which has been developed by the Cambridge group. Measurements are made on the quiet sun using a simple interferometer at a series of different spacings. The distribution of intensity across the sun can then be deduced by a Fourier transformation process. Results are now available at four wave lengths, and attempts are being made to fit them with a model corona in which the temperature varies with height.

The intensity distribution across the solar disk can also be studied at a solar eclipse. Observations were made by three groups at the total eclipse at Khartoum last February. These were reported by Dr. J. L. Steinberg, of l'Ecole Normale Supérieure, Paris; Dr. J. P. Hagen, of the Naval Research Laboratory, Washington, D.C.; and Dr. M. Laffineur, of l'Institut d'Astrophysique, Paris. Records were made at six wave lengths extending from eight millimeters to two meters. These have not yet been completely reduced, but several give evidence that the sun was not radially symmetrical.

S. F. Smerd, of Sydney, stated that recent observational results on brightness distribution could not be fitted to an optically derived model of the corona, with any temperature assumption at all. He suggested that this may be because the radio and optical coronas are essentially different. The radio measurements may refer to the high-density regions, the coronal streamers, whereas the optical ob-

(Continued on page 70)

Color-Magnitude Diagrams and Stellar Evolution

BY OTTO STRUVE, *Leuschner Observatory, University of California*

THE GREAT PRECISION attainable in the measurement of the brightnesses and colors of the stars with modern photoelectric photometers has given new impetus to the study of diagrams in which the intrinsic absolute magnitudes of the stars are plotted against their colors. In principle, such graphs are equivalent to the Hertzsprung-Russell diagrams in which the absolute magnitudes of the stars are plotted against their spectral types. They have been used extensively by many pioneering astronomers, for example, by H. Shapley in his famous studies of the globular clusters.

The recent increase in precision has been most convincingly demonstrated in a series of color-magnitude diagrams of several open or galactic clusters by Harold Johnson, at the McDonald Observatory, and in two diagrams of the globular clusters M3 and M92, by H. C. Arp, W. A. Baum, and A. R. Sandage, at the Mount Wilson and Palomar Observatories. The former were obtained with a photoelectric photometer; a yellow, a blue, and an ultraviolet filter were used to derive the colors. The measurements of the globular clusters were calibrated photoelectrically for selected stars, and the rest of the stars were then measured on photographs.

Fig. 1 shows the diagram obtained by Johnson and W. W. Morgan for the Pleiades, while Fig. 2 is for the open cluster of Praesepe (the Beehive). The diagonal array of dots is, of course, the main sequence, and (except for differences in the scales and zero points) these arrays coincide in the two clusters, except at the upper ends. But the scatter is larger in the Pleiades than in Praesepe. This was already noticed for the Pleiades by O. J. Eggen, who described some of his color-luminosity arrays in the November, 1951, issue of *Sky and Telescope,* but the Yerkes-McDonald astronomers do not confirm the individual sequences which Eggen's diagram had suggested.

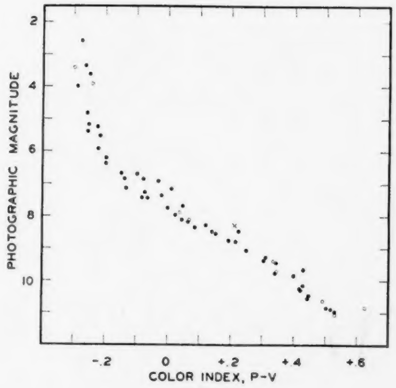


Fig. 1. A color-magnitude diagram of the Pleiades, by Johnson and Morgan. The cross corresponds to a star that is heavily embedded in nebulosity. From the "Astrophysical Journal."

The difference is largely one of interpretation. Both sets of observations indicate certain regions, along the main sequence, where the scatter is appreciably larger than in other regions, and in the case of medium blue stars (color index photographic minus visual, P − V, between −0.1 and +0.1) it is perhaps a debatable question whether there are two narrow sequences or one sequence with a large dispersion. But I am inclined to agree with Morgan and Johnson that the latter interpretation is, for the time being, the simpler of the two and, moreover, it is theoretically just as good as the other.

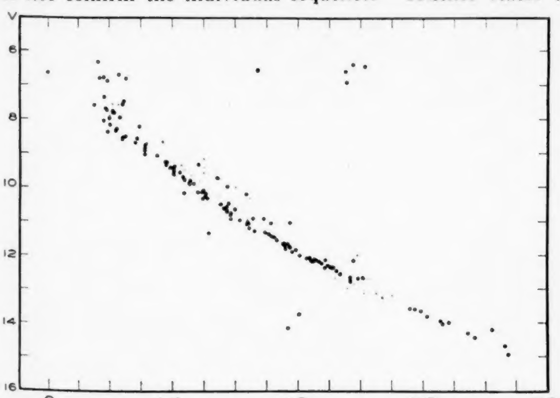
Very recent observations of the Pleiades by W. A. Hiltner have given the probable errors of his own and Johnson's observations. They are considerably less than 1/100 of a stellar magnitude, in color as well as in brightness, and thus probably represent the ultimate in photometric precision yet attained. Hiltner states that his color-magnitude diagram is so nearly identical with the one by Johnson and Morgan that he did not even bother to publish it: No star would have to be moved more than the diameter of the dot representing it in the Johnson-Morgan illustration (Fig. 1).

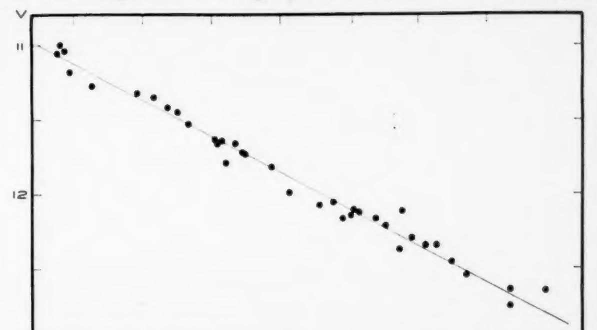
The large scatter in the Pleiades may be caused by absorption of light in the nebulosity which envelops this cluster. But Harold Johnson has told me that he has observed another galactic cluster without any visible nebulosity in which the scatter is even larger. Thus, in this respect, we accept the opinion of Eggen that there exist real physical differences among the cluster stars, even though their colors may be identical.

At the upper ends, the stars of the galactic clusters scatter widely, and the main sequence seems to curve steeply toward the top of the diagrams, departing from the usual prolongation of the main sequence. This is a well-known effect. It was discovered by R. J. Trumpler and was later interpreted by G. P. Kuiper as a consequence of evolutionary changes in the hotter stars of each cluster. The idea (amplified in my book on stellar evolution) is that the different galactic clusters originally consisted of young stars, all rich in hydrogen. In the course of some tens of millions of years, the hottest stars of each cluster would have converted their hydrogen into helium and this would have caused them to change their positions in the diagrams.

The observations suggested that there are now in existence very young clusters, like h and Chi Persei, in which the normal main sequence is even now intact as far as the hottest *B* and *O* stars. But other clusters, such as the Hyades, are old—perhaps a few hundred million or even one or two billion years of age—and they have lost their blue stars.

At that time (about 1938), there was only a rudimentary theory of stellar energy production, and B. Stroemgren





Left: Fig. 2. A color-magnitude diagram of the Beehive, by Johnson. Above: Fig. 3. An enlarged portion of the main sequence of Fig. 2.

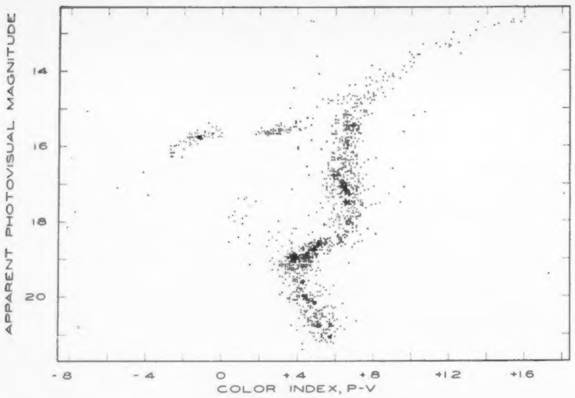


Fig. 4. A color-magnitude diagram of the globular cluster M3, by Arp, Baum, and Sandage. This cluster is pictured on the back cover.

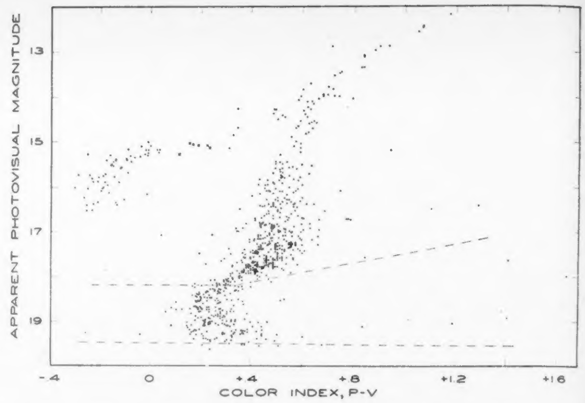


Fig. 5. A color-magnitude diagram of the globular cluster M92, by Arp, Baum, and Sandage, plotted on a slightly different scale than Fig. 4.

had suggested that these hot blue stars might have moved to the right sides of the diagrams, becoming in effect real giants. But the theory was at first not confirmed by later advances in nuclear physics, and it remained uncertain whether there would really be a movement of the stars along horizontal tracks into the domain of the red giants.

It is of interest that the main sequence of Praesepe looks as though it consisted of two parallel branches, about half a magnitude apart. This is due to the presence of binary stars in the cluster. A system of two unresolved stellar components of identical temperature and brightness would be observed three quarters of a magnitude too bright. Since not all binaries consist of identical components, the observations of these unresolved double stars scatter between the true main sequence and the three-quarter magnitude limit above it.

Figs. 4 and 5 show the color-magnitude diagrams of the well-known globular clusters, M3 and M92, while Fig. 6 is a sketch of the principal sequences of these diagrams (Population II) superposed over the conventional diagram of the stars in the neighborhood of the sun (Population I). The latter is shown by the shaded areas. At first sight, there appears to be a tremendous difference between the two stellar populations. But the main sequence is present in both, although in the globular clusters only a short stub of it is apparent. Their main sequences are limited at their lower ends because the stars are too faint to be observed; undoubtedly there are many faint red dwarfs in the unobserved lower region of the main sequence. But at the top the main sequences are fairly sharply bounded.

The horizontal branches which bridge the conventional Hertzsprung gap of Population I extend far to the left and include, in both clusters, a number of very blue stars, with color indices of the order of −0.65 magnitude, which resemble the blue galactic stars discovered by Humason and Zwicky, and also by MacRae, Fleischer, and Weston (*Sky and Telescope*, April, 1951, page 140). In M3 the short-period variable stars were omitted. In M92 they are shown as crosses. Arp, Baum, and Sandage conclude that these RR Lyrae-type variables "are all isolated in a small segment of the horizontal branch of the array, in which region there are no non-variable stars present." M. Schwarzschild suggested, many years ago, that all stars possessing certain definite values of brightness and color tend to vibrate, or pulsate. This idea finds strong support in the new Mount Wilson data.

As we shall see, the most interesting information is obtained from a study of the strangely bent, nearly vertical, giant branches. Although they do not coincide in these two clusters, both join with the main sequence at about absolute magnitude +3.5.

There is no doubt that these color-luminosity diagrams (or their equivalents—the original Russell-Hertzsprung diagrams) contain a powerful key to the solution of the problem of stellar evolution. But we must actually get hold of the key before we can unlock the secret. An important and perhaps decisive step in this direction has been made by Sandage and Schwarzschild in a theoretical paper being published in the *Astrophysical Journal*. Their ideas will be discussed briefly here.

What happens to a star as it gradually converts its hydrogen into helium by means of the nuclear chain reaction known as the carbon cycle? The nuclear processes involved are very sensitive to the temperature of the medium. If the temperature is a little lower than 20 million degrees they are almost inoperative; at about 20 million degrees and above, on the other hand, they are very efficient.

We know that the temperature of a star increases from the surface, where it is of the order of a few thousands of degrees, toward the center, where it exceeds the critical value required for the nuclear processes. Hence, the conversion of hydrogen into helium takes place only in the deep interiors of the stars. In the earlier discussions of stellar interiors, astronomers even spoke of a "point-source" model as representing the physical conditions inside the sun.

But it became gradually apparent, largely through the work of T. G. Cowling, that in the region surrounding the center of the star there must be violent convection of the gases, with a consequent mixing of the material inside this convective core. Hence, all the hydrogen of the core passes many times through the hot center, and is there subjected to the carbon cycle.

Outside the convective core the mixing of the material is exceedingly slow (except perhaps in rapidly rotating stars). Hence this envelope remains rich in hydrogen—its temperature is too low for the nuclear processes, and its hydrogen atoms do not travel toward the center in the form of convective currents.

Gradually the convective core would become exhausted of hydrogen, and would then consist only of helium and those heavier elements that were already present in the original cosmic material out of which the star was built. What would happen next was a difficult problem, and its solution required all the mathematical and physical skill that S. Chandrasekhar and Mario Schoenberg could muster. They showed that with the dying out of the nuclear energy production near the star's center the driving force for maintaining the convective currents in the core would also disappear. The gas would come to rest and would no longer contain any sources of energy, but would, of course, be surrounded by the intensely hot envelope with its normal supply of hydrogen. This would tend to convert the convective core into an isothermal core—a mass of gas at a uniform temperature of the order of 20 million degrees, or slightly more.

Chandrasekhar and Schoenberg have shown that the isothermal core will at first grow in mass and in radius. Being surrounded by a thin spherical shell whose temperature is now of the order of 20 million degrees, this shell becomes the source of the stellar nuclear energy production, and as its hydrogen is converted into helium the resulting material is added to the isothermal core. At the same time the temperature of the core rises, and the energy production passes on to the layer just outside of the "burned-out" shell.*

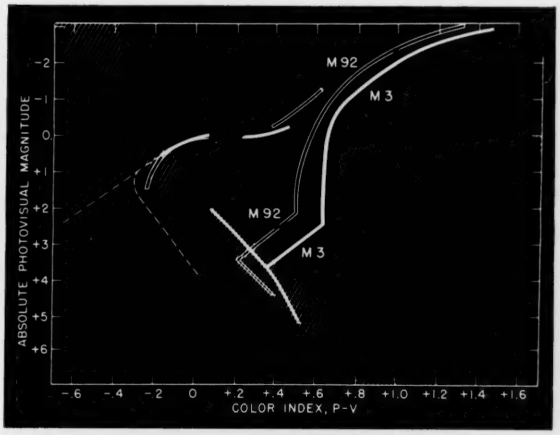
However, this process of growth in the isothermal core cannot continue for long. It stops before all of the envelope is used up. As Chandrasekhar has stated, "it follows from quite general considerations that we cannot fit into a star an isothermal core beyond a certain maximum size. The reason for this is, physically, that in a star . . . we cannot build a steep enough temperature gradient in the outer parts to maintain more than a certain fraction of the mass at the highest temperature." This fraction turns out to be about 12 per cent of the total mass of the star. Chandrasekhar concluded that "it would seem that when the isothermal core has expanded to its maximum size the secular evolution (by nuclear processes) will be definitely stalled." And in its final stages, "the star has recourse to contracting in the manner imagined by Helmholtz and Kelvin, releasing gravitational energy."

It is with this late stage in the life of a star that the work of Schwarzschild and Sandage is concerned. Even before the outer envelope has consumed all the hydrogen it can, the isothermal core begins to contract, thereby releasing what appears to be a rather small amount of energy—so small in fact that for all practical purposes the light and heat we observe come entirely from the nuclear processes in the thin layer surrounding the isothermal core.

Yet, it is this effect of contraction of the core that has unexpected and rather spectacular consequences: As the core condenses, the envelope becomes greatly blown out. The visible radius of the star increases, and its surface area increases as the square of the radius. The temperature of the photosphere decreases, so that the total luminosity of the star changes but little.

The result of the accurate computations of Sandage and Schwarzschild is illustrated in Fig. 7. We start with five young stars, possessing their full normal supply of hydrogen and differing only in mass: 4, 3, 2, 1.5, and 1 times the mass of the sun, respectively. As the hydrogen begins to be converted into helium in the convective core, each star at first moves sharply upward, from its original location on the diagonal line representing the main sequence. This part of the five curves was already known from the work of Chandrasekhar and Schoenberg,

Fig. 6. A schematic representation of color-magnitude diagrams of Population I (shaded areas) and of Population II (globular clusters M92 and M3). The empty region near the middle of the upper giant branches of both clusters is occupied by the pulsating variable stars which were omitted in this investigation. In Population I the horizontal giant branch does not join the main sequence; the space between is called the Hertzsprung gap.



and there have been many elaborations of it in recent years. The luminosity increases by about one stellar magnitude, and each star appears a little to the right of the main sequence.

As the 12-per-cent limit of the core is approached, the gravitational contraction of the core becomes effective, and each star moves rapidly to the right, on an approximately horizontal line. It becomes a typical giant.

The length of time required for the stars to pursue this course is not the same for all five of them. The more massive stars, with their large luminosities, rapidly exhaust their hydrogen, and for them the entire process may require only some millions of years. Stars having masses smaller than that of the sun have not yet turned even their first 12 per cent of material into helium, and are therefore still on the main sequence. Stars of slightly more than the mass of the sun require about three billion years to reach the horizontal branch of the evolutionary curves. These stars fall between the two curves in Fig. 7 labeled 1.5 and 1 solar masses. Their absolute magnitudes are near 3.3, precisely the point in the globular cluster diagrams where the giant branch conspicuously branches off the main sequence. This agreement is truly amazing; it shows that the Sandage-Schwarzschild model must indeed be close to the truth.

The observations (Fig. 6) showed that in the globular clusters the (almost) horizontal giant branch is, on the right-hand side, followed by an almost vertical branch that finally, at its upper end, trails off more nearly horizontally to the right. Sandage and Schwarzschild believe that this may be due to a new nuclear process of converting helium into heavier elements which was recently announced by E. E. Salpeter (see News Notes, July, 1952, page 218). If it were not for this process, which starts when the isothermal core has reached a temperature of the order of 100 million degrees, the evolutionary track described by Sandage and Schwarzschild would remain horizontal and extend indefinitely toward the cooler surface temperatures in the H-R diagram, or the redder colors in the color-magnitude diagrams.

The five vertical branches at the right in Fig. 7 are based upon an estimate of the manner in which Salpeter's process will affect a star's luminosity and color. Presumably, there would develop a new convective core, which in turn would give way to a new isothermal region—of very high temperature—which again would contract and release gravitational

(Continued on page 75)

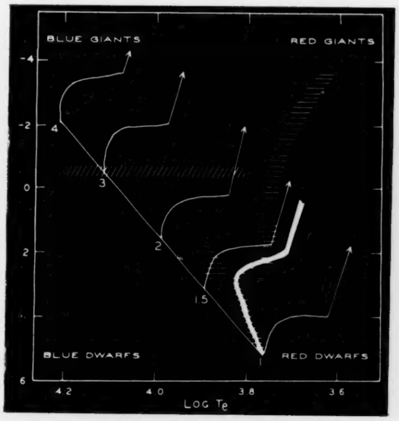


Fig. 7. A schematic representation by Sandage and Schwarzschild of the evolutionary tracks in the color-magnitude diagram for stars of different masses. The heavy line represents the path of stars somewhat more massive than the sun, all starting 3½ billion years ago, and strikingly displays the features of the lower portion of the observed diagram of Population II for the globular clusters M3 and M92 (Fig. 6). The vertical scale is absolute bolometric magnitude; the horizontal scale is the logarithm of the effective temperature.

---

* **Sky and Telescope** articles dealing with energy production problems are: "The Source of Energy in the Fainter Stars," Lawrence H. Aller, April, 1951, page 138, and "The Problem of the Red Giant Stars," Lloyd Motz, May, 1951, page 170. — ED.

Queen of the Untraveled Seas

By Leland S. Copeland

The broad expanse of Mare Imbrium, most famous of lunar seas. The central part of this 100-inch photograph is reproduced to a large scale on a separate sheet in the center of this issue. It should be removed from the staples to be used for detailed study with this article or at the telescope; it can be mounted or placed in a transparency case. A soft pencil will aid in eliminating the crease. Mount Wilson and Palomar Observatories photo.

INVITATIONS to visit Mare Imbrium, the Sea of Showers, are rained each month on the home yard of every owner of an amateur telescope. And rarely does an earthly summons beckon to such strange and choice entertainment, because Mare Imbrium is the largest and handsomest lunar sea, conspicuously placed for observation from the earth. Only the Ocean of Storms surpasses it in size.

If California could be carried to the moon and its surface bent to fit the more abrupt curvature of our satellite, the Golden State would bridge the Sea of Showers along its major dimension. This distance, 750 miles, would reach from New York to Atlanta, from Baltimore to St. Louis, and from Chicago to Mobile. In area Mare Imbrium equals the northeastern United States, including not only New England, but New York, New Jersey, Delaware, Maryland, Pennsylvania, West Virginia, Ohio, Indiana, and most of Michigan.

This great lava plain, which early observers supposed to be a sea, reaches from the Apennine and Caucasus ranges on the west to the small ring mountains of Diophantus, Delisle, and Gruithuisen on the east; from mysterious Eratosthenes and the Carpathians on the south to the Alps, Plato, and lovely Sinus Iridum, Bay of Rainbows, on the north. Though seemingly an ellipse, it really is nearly circular — a shape distorted by the curving lunar surface.

Indeed, Mare Imbrium resembles a great circular walled plain like Ptolemaeus and Clavius, marvels farther south, though its eastern shore is missing. Perhaps the same forces that created these walled plains fashioned Mare Imbrium. Not only do its mountain ranges lie along a circumference approximately circular, but they fall more or less steeply to the inner plain, while sloping down gradually outside. These details suggest a great uplift, followed by subsidence and cooling.

But a learned writer recently argued that the Sea of Showers was produced by a falling asteroid.* An argument against this conclusion is the missing eastern shore, which such a tremendous catastrophe should have formed. Also, more asteroids would have to be imagined to explain the other seas, including two for Mare Nectaris, because it has an old shore line, the Altai Mountains.

Though Mare Imbrium seems to be a relatively unbroken plain, it really is dotted with tiny craters. Walter Goodacre, English selenographer, counted 600 of these midgets. Were they formed by volcanic forces or by meteoritic impacts?

Those who like to believe that meteorites made the lunar rings must explain how so many huge blocks could have descended on the southwest of our satellite, while smaller fragments, with few exceptions, rained on the east and the northeast. Did an asteroid destroy earlier, grander rings of the Sea of Showers? But whence would come the asteroid and all the ring-making meteorites?

Of the three leading meteoritic craters on earth, the largest, Ungava in Canada, is two miles in diameter, and the other two, Meteor Crater of Arizona and Wolf Creek in Australia, are less than a mile in width. Among terrestrial volcanoes, Crater Lake, Oregon, and Haleakala (House of the Sun), Hawaii, are each about six miles in diameter; Asosan in Japan is 15 miles at its widest, and Volcano Bay, Japan, extends across 35 miles, according to W. H. Pickering, the lunar expert. That is, considering existing terrestrial craters,

*See Books and the Sky, September, 1952.

The angel of the Bay of Rainbows, as seen by John Russell, R.A., 18th-century portrait painter. From the "Illustrated London News," October 18, 1930.

volcanic agencies have built them three to 18 times as large as have meteorites.

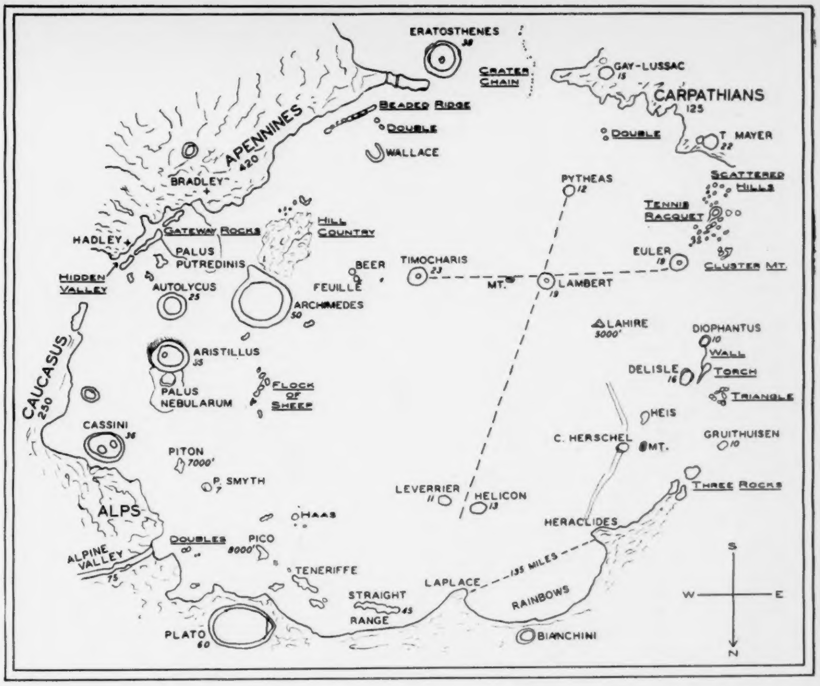
Because meteoritic depressions are found on earth, undoubtedly they exist also on the moon. But all of such lunar rings may be small, like those on earth. If so, they are not characteristic. We know, also, that the fiery forces that made great terrestrial craters would have been far more effective on the moon because of weaker gravitation there and absence of air pressure, and because the lunar substance is lighter. So Volcano Bay, nearly as big as Eratosthenes, is equivalent to much larger rings farther south on the moon.

Oddly, all rings of Mare Imbrium are relatively small, except glorious Plato, 60 miles in diameter, and clear-shining Archimedes, 50 miles. Eratosthenes, 38; Cassini, 36; and Aristillus, 35, rank next in size. Others are 25 miles or less.

Especially pleasing among features of Mare Imbrium is a replica of the Northern Cross. Deneb is represented by Pytheas and the double Albireo by the twins, Leverrier and Helicon, while stars of the arms are depicted by Timocharis, Lambert, and Euler. These six names show that lunar terms are international. They honor three ancient Greeks, and a German, a Swiss, and a Frenchman. The Frenchman, Leverrier, was codiscoverer of Neptune.

Loveliest of lunar sights is Heraclides Promontory when our satellite is about 10 days old. This headland of Sinus Iridum then appears as the angel of the Bay. She has a cherub wing, and she wears a ribbon about her head. Also she reaches an arm down to Bianchini, which, like a silver bowl, she holds in her left hand. Three or four nights later she has changed into a devil. What a transformation!

In the lunar morning, Laplace, western promontory of Sinus Iridum, shows small craters on its crest and casts a shadow cone into the bay. Late in the afternoon this headland and the rugged region northeast of it become the so-called Moon Maiden. Shining-faced, she gazes toward Heraclides, while she reclines along the curving shore. Certainly she would not win in a beauty contest.



The author's chart of Mare Imbrium. All underscored words are peculiar to this discussion, suggesting the appearance of the formations so named. The numbers, giving sizes in miles, are from "The Moon," by Walter Goodacre.

The Bay of Rainbows, silvery bow spanning 135 miles, offers the ideal site for a lunar metropolis, if some governmental agency, outpouring taxpayers' money, would provide air and water. And buried cities could be found there, if our satellite ever had inhabitants, or so mused Garrett P. Serviss, who wrote so entertainingly about the moon. The floor of this formation is not smooth. Under favorable lighting, six or seven low ridges appear upon it, if observers include the area within an outcurving arc connecting the two headlands.

Which is older, Mare Imbrium or its Bay of Rainbows? Did Sinus Iridum once have a southern wall, later melted away by a lava flood? Or were both formed at the same time?

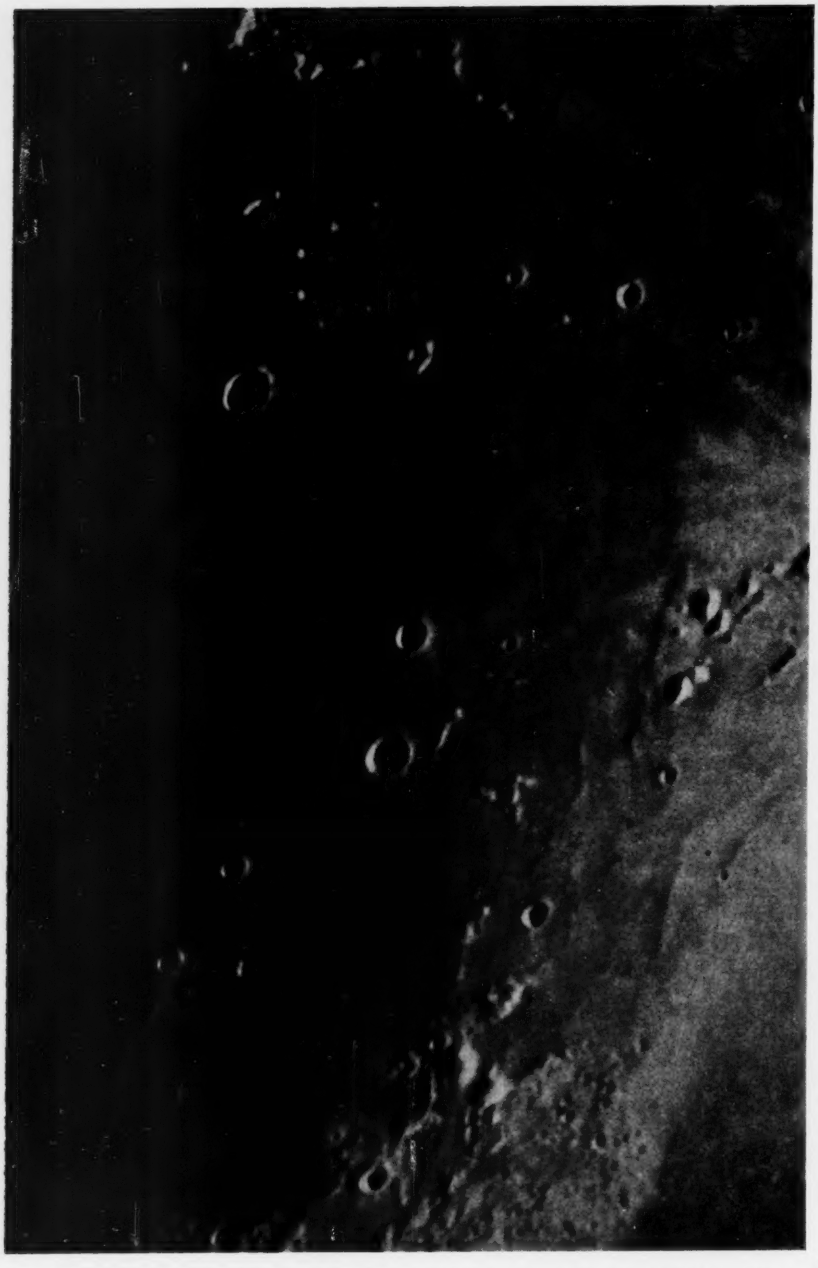
What a spectacle is Plato, a walled plain, apparently oval, but nearly circular! The great detached mountain mass within its eastern rim resembles the rudimentary nictitating membrane in the inner corner of the human eye. Observatory photographs show a dozen craters dotting Plato's spacious floor.

Between this marvel and Laplace lies the Straight Range, 45 miles long. West of this rugged "island" are four formations telling a story — Teneriffe Mountains, Piazzi Smyth, and two isolated summits, Pico and Piton. Piazzi Smyth, whose given name recalls the discoverer of Ceres, went to the Canary Islands to study the effect of elevation on seeing. His experiments, lasting for many months, were made on Pico de Teyde, chief feature of Teneriffe Island. The highest point of this mountain is El Piton, a volcano.

These isolated peaks, Pico and Piton, seem similar to those found within Copernicus, Tycho, and other great rings. Some supporters of the meteoritic hypothesis believe that central peaks were raised by the back-splash from impacts. But the numerous solitary mountains of Mare Imbrium are rocky towers without encircling walls.

Another lonely mountain, rugged, elongated, rises south of Pico. Just east of it is a ring about six miles in diameter, guarded by three smaller pits, forming a triangle. This crater holds our attention because H. Percy Wilkins, on his 300-inch map, has printed *Haas* be-

A drawing of the lunar mountain Pico, by J. Nasmyth.



The eastern edge of the Sea of Showers. At the top are the Carpathians, with the "Scattered Hills" just below, including the "Tennis Racquet" and "Cluster Mountain." At the center, near Delisle and Diophantus, are the "Torch" and "Triangle Mountain." Below the latter is Gruithuisen, which is above the "Three Rocks." To the left is the crater Caroline Herschel, emphasized by ridges extending north and south. Lick Observatory photo, courtesy J. F. Chappell.

side it. Walter H. Haas, of Las Cruces, N.M., is director of the Association of Lunar and Planetary Observers, enthusiasts for better definition and trained eyesight. In honor of another member of this group, David P. Barcroft, of Madera, Calif., a lunar formation, Dollond B, has been renamed *Barcroft.*

West of Pico is the famous Alpine Valley, four to six miles wide by 75 long. And west of Piton stands Cassini, a ring remarkable for having within it both peaks and relatively large craters.

Traveling southward, we reach Misty Marsh (Palus Nebularum), bounded by waving ridges. South of this inconspicuous detail are Aristillus and Autolycus. In a Mount Wilson picture, both show sheer inner rims, and Aristillus wears a wide rugged collar of hills.

Great Archimedes, like a jeweled ring, rises east of these wonders. Its "gem" is an outlying mountain block, a poser for meteoritic theorists. This detail is not unique; two other rings with "jewels" can be found in the Sea of Clouds (Mare Nubium), Kies and Lubiniezky, both near great Bullialdus.

North of Archimedes rises an eye-arresting group of a dozen peaks, the ***flock of sheep,*** as they have been called by Hugh G. Boutell, Santa Barbara variable star lover. And south of Archimedes is a charming ***hill country,*** brightest area of Mare Imbrium.

Outstanding in interest and beauty are Palus Putredinis, a great esplanade southwest of Archimedes, and *gateway rocks,* at its western end, opening on a long valley lining the inner curve of the Apennines. Palus Putredinis is an inappropriate name for a pleasing region on a waterless, airless, and scentless globe. Let us leave it untranslated.

The name *gateway rocks* is used here because this grand portal suggests the up-ended sandstone blocks (Permian) through which one enters the Garden of the Gods at Colorado Springs. Our lunar gateway is far loftier and wider than its Colorado counterpart. Its width may be estimated at five miles, but the opening is partly blocked by at least two round hills.

If, winding among these knobs, we should enter the *hidden valley,* we should find a retreat about 11 miles wide, stretching southward 44 miles and, on the north, reaching nearly to the strait opening into Mare Serenitatis. Passing through the *gateway rocks* we should see on our right a small crater, and between it and the Apennines a long cleft winding down, snakelike, from the mountains to the gateway, through which it seems to pass out into the esplanade. This crater and the southern end of this cleft I have been able to see through an 8-inch reflector built by Thomas R. Cave, Jr., with a Goodwin Barlow lens on the eyepiece. Another cleft, more easily discernible, wanders from Palus Putredinis for about 75 miles, toward the southeast, across the foothills of the Apennines.

Standing on the esplanade, we could observe Mt. Hadley, 15,000 feet, on our left, and Mt. Bradley, 13,000 feet, on our right. Hadley and Mt. Whitney, California, supreme summit of the continental United States, have about the same elevation.

Especially pleasing is a double crater between Archimedes and Timocharis. These small rings are Beer and Feuillé. There is also a pair south of Wallace, another north of Gay-Lussac, and three dim ***doubles*** on the plain near Alpine Valley. Why do so many lunar rings come in twos and threes?

Slumbering southeast of the Archimedes hill country is the half-hidden U-shaped mountain Wallace, honoring Alfred Russel Wallace, codiscoverer of the principle of natural selection. Of its

southwestern rim only fragments can be glimpsed.

Noting the *beaded ridge* between Wallace and the Apennines, let us hasten on, to look down into mysterious terraced Eratosthenes. William H. Pickering peered down often and thought that he saw evidences of life, possibly moving swarms of insects.

Between Eratosthenes and the Carpathians winds a broken chain of small craters. From this *crater chain* extends northward the largest of six or more bright rays that splash across the southern border of the Sea of Showers. This great band seems to come from Tycho, rather than from Copernicus. But perhaps we only imagine that we can glimpse traces of it in the Sea of Clouds.

Forming the southernmost curve of the Sea of Showers stands the Carpathian chain. The northern edge of this range holds at least three inviting bays into which no ship has run, and two conspicuous small rings, Gay-Lussac and Tobias Mayer.

At last we have reached the landmarks of the eastern edge of Mare Imbrium. Amateurs examine these objects less frequently than the wonders of the western rim. Yet the great wide spaces of the east call attention to rings and summits which, though relatively few, are remarkable.

Why no grandeur here? Because instead of an arching range we have a very wide strait, similar to those narrows uniting the great seas farther west. Its exceptional width may have resulted from nearness to the mighty Ocean of Storms. Perhaps the titanic forces that fashioned Mare Imbrium and Oceanus Procellarum repressed each other.

Moving northward among the eastern landmarks, we meet a nest of about 50 *scattered hills*, southeast of Euler. Among these is the *tennis racquet*, another jeweled ring, but with the gem lengthened into a short handle. Close to the northern edge of this nest rises *cluster mountain*, with six or seven peaks.

Farther north are Diophantus and Delisle, and a mountain mass resembling a *torch*, from which a *wall* runs to Diophantus. Though experts have regarded this barrier as a ridge, it seems to be similar to the Straight Wall (Railway) of Mare Nubium. At least, it is black in the morning and shining white in the afternoon, whereas ridges show white and black lines at the same time.

A noteworthy *triangle* of mountains, rising near the *torch*, reminds one of the group of peaks within Petavius. Below them is Gruithuisen, above three conspicuous mountain blocks. Let us call this trio the *three rocks*. Selenographers seemingly have failed to appreciate their importance. They stand like sentinels at land's-end of the mountainous area east of the Bay of Rainbows. The southern rock somewhat resembles a mesa. Though the other two are roundish in amateur telescopes, both of them show peaks in Lick photographs; so they are mountains and not like the "bubble hills" near Arago.

Our tour ends at a small ring honoring Caroline Herschel. This lies southwest of the *three rocks* and forms a triangle with crater Heis and an isolated *mountain*. Though Caroline Herschel is small, it is emphasized by strongly marked ridges running north nearly to Heraclides and south toward the great mountain monarch Lahire.

All this time we have been studying little more than the right eye of the man in the moon, Mare Imbrium. Indeed, our satellite, like Shakespeare's Cleopatra, has "infinite variety." From its richness it repeatedly rewards the amateur with a surprise, a detail seldom, if ever, glimpsed by him before.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 14, Mass. Richmond 2-1410.

SCHEDULE: Tuesday through Friday, 3 and 4 p.m.; Saturday, 11 a.m., 2, 3, and 4 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector. Acting director, John Patterson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium.* Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11:15 a.m. Special showings on request. Admission free. Spitz projector. Director, Louise L. Morlang.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:00 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.

SCHEDULE: Saturday, 3:00 p.m.; Sunday, 3:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday, Thursday, and Friday at 8:30 p.m.; Saturday and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NASHVILLE: *Sudekum Planetarium.* Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., 42-1853.

SCHEDULE: Sunday, 2:45, 3:30, 4:15. Spitz projector. Director, William G. Hassler.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Chairman, Robert R. Coles.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

SCHEDULE: Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

SAN FRANCISCO: *Morrison Planetarium.* California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday) at 3:30, 7:30, and 9 p.m.; also at 2 p.m. on weekends and holidays. Academy projector. Manager, George W. Bunton.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:00 p.m. Special showings on request. Admission free. Spitz projector. Director, Ernest T. Luhde.

Amateur Astronomers

FALL INSTRUMENT MEETING AT CAMBRIDGE, MASSACHUSETTS

STELLAFANE, a nostalgic memory to many who have contributed to the national growth of amateur astronomy, is an enchanted word, remote to those who have more recently been captivated by this fascinating avocation. Books on telescope making have done much to perpetuate the lore and technique but the annual assembly of instruments at Springfield, Vt., so encouraging to practical improvement and progress, has been sorely missed. The need for a gathering devoted exclusively to telescope making grows with time and has been frequently voiced in many groups.

Encouraged by this general agreement, the Amateur Telescope Makers of Boston will hold an instrument convention at Cambridge, Mass., on October 11, 1953, with the sanction of the Harvard College Observatory and the approval of the Northeast regional council of the Astronomical League. The date, falling on Columbus Day weekend immediately after the annual meeting of the American Association of Variable Star Observers, minimizes extra and conflicting schedules and offers a doubleheader to those who will travel to Boston.

The 1953 instrument meeting will be a symposium of astronomical instruments and devices and all allied accessories. There is time to complete your pet project or to get it in shape to exhibit. Because there are so many today who have not been to Stellafane, a review of instruments previously exhibited would be beneficial.

Among those who have assured their co-operation are host Dr. D. H. Menzel, acting director of Harvard Observatory, and Dr. Joseph Ashbrook, Dr. J. G. Baker, Hartness Beardsley, Stanley Brower, Ralph Dakin, R. B. Dunn, C. A. Federer, Jr., Clinton Ford, C. E. Johnson, C. H. LeRoy, Mrs. M. W. Mayall, Dr. Henry Paul, E. M. Root, D. W. Rosebrugh, Dr. C. H. Smiley, Paul Stevens, John Streeter, Mrs. Helen Velardi, Rev. G. W. Walker, J. E. Welch. John Pierce and Ernest Flanders will head a delegation from Springfield, Vt., bringing a special exhibit.

An open invitation is extended to all. Early response from those who plan to attend will be most welcome.

JAMES W. GAGAN
Amateur Telescope Makers of Boston
Harvard Observatory
Cambridge 38, Mass.

LEAGUE GENERAL CONVENTION

THIS YEAR'S Astronomical League convention will take place in Washington, D. C., September 4-7, with the National Capital Astronomers as host society. The sessions will be held at the Carnegie Institution of Washington, 16th and P Sts., N.W. Ample space will be available for exhibits. Arrangements will be made for council meetings and meetings of the Middle East region.

G. R. Wright has been appointed convention manager. Tentative plans include a trip through the Naval Observatory, and a visit to the NCA Observatory. There will be observing, weather permitting. An outdoor buffet supper is planned at the Georgetown University Observatory, with observing. Visits will also be arranged to some of the radio astronomy projects being carried on in the Washington area. Travel to and from these places will be by chartered bus.

Housing for those who attend the convention will be in nearby hotels. Since Washington is a favorite sightseeing place and is always crowded over holiday weekends, it will be necessary to make all convention reservations at an early date. Many who attend may wish to spend more time sightseeing than will be possible during the convention period, so the NCA plans to handle reservations to cover several days preceding and following the convention. Those who desire early information concerning registrations may write to Mrs. Ione Alston, 20 Plattsburg Court, N.W., Washington 16, D. C.

The 1951 league convention was at Chapel Hill, N. C., coincident with the annular eclipse of September 1st that year. In 1952 the league met in Dallas, Tex. For 1954, the convention will be in Madison, Wis., over the 4th of July. Many amateur astronomers are expected to be in that area on June 30th to view the total eclipse of the sun.

ASTRONOMY DEMONSTRATIONS IN BUFFALO, NEW YORK

Private star parties, for groups large and small, young and old, may be arranged for any time through this May as a new service by the Buffalo Museum of Science. Under Dr. F. Shirley Jones, of the museum staff, at each demonstration the sky will be viewed in the Kellogg hall of astronomy using the Spitz planetarium, and from the roof of the museum with the 8-inch Lundin refractor of the Kellogg Observatory and small telescopes.

Special topics may be arranged for in advance, and date and time booked at the convenience of the group, during evening as well as daytime hours. A fee of not more than 25 cents per person may be necessary, depending on the demand for the service. Any class, club, or miscellaneous group may receive further information from Mrs. Charles D. Emigh, Buffalo Museum of Science, Humboldt Park, Buffalo 11, N. Y., telephone GRant 4100.

THIS MONTH'S MEETINGS

Buffalo, N. Y.: Buffalo Astronomical Association, 8 p.m., Buffalo Museum of Science. Jan. 7, Dr. Lyle Phillips, University of Buffalo, "Time as a Fundamental Concept."

Cambridge, Mass.: Bond Astronomical Club and Amateur Telescope Makers of Boston, joint meeting, 8 p.m., Harvard Observatory. Jan. 8, Edward Lilley, Harvard Observatory, "Progress in Radio Astronomy." Movies on stellar evolution.

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. Dr. Victor Blanco, Warner and Swasey Observatory, "Life in Other Worlds."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. Jan. 26, E. M. Brewer, "The Planets."

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. Jan. 13, V. A. Carpenter, "Astronomy in Daytime."

Milwaukee, Wis.: Milwaukee Astronomical Society, 7:45 p.m., Milwaukee Public Library. Jan. 12, Dr. Bengt Stroemgren, Yerkes Observatory, "Stellar Evolution."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Jan. 7, Kenneth Heuer, "End of the World: A Scientific Inquiry."

Port Arthur, Tex.: Port Arthur Astronomy Club, 7:30 p.m., home of Mr. and Mrs. W. C. Piggott, 5228 Fifth St. Jan. 8, E. W. Torrence, U. S. Weather Bureau, "The Atmosphere."

Rutherford, N. J.: Astronomical Society of Rutherford, 8 p.m., YMCA. Jan. 8, Paul J. Hagar, "Twenty Three and One-Half Degrees."

South Bend, Ind.: St. Joseph Valley Astronomers, 8 p.m., Hotel LaSalle. E. J. Gabrich, "The Perils of Space Travel."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Building auditorium. Jan. 3, James M. Kendall, Naval Ordnance Laboratory, "Light from Planetary Nebulae."

RADIO ASTRONOMY AT THE URSI ASSEMBLY

(Continued from page 62)

servations favor the regions of mean density, where the temperature is high.

One of the sessions was devoted to the dynamics of ionized media. The discussion showed that this is a very difficult subject, and a thorough understanding of the nonthermal processes that are important in radio astronomy is still a long way off.

In addition to the technical sessions, a number of decisions were reached on business matters. A scheme was drawn up for the naming and cataloguing of discrete sources, and sent on as a recommendation to the International Astronomical Union, which would be responsible for its administration. The operation of the world chain of solar radio observatories was discussed at length, with particular emphasis on the calibration of equipment and the publication of results. The intensity of 10-cm. solar radiation is being considered as a possible new basic solar index. Groups were appointed to draw up special reports on interstellar hydrogen, discrete sources, the distribution of radio brightness on the solar disk, and meteors.

The next URSI assembly will be in the Netherlands in 1954. The Sydney discussions demonstrated that radio astronomy is developing vigorously. There should be more to tell in two years' time.

Graphic Time Table of the Heavens -- 1953

Discussion by Paul W. Stevens

FIRST ISSUED by the Maryland Academy of Sciences in 1937, the Graphic Time Table of the Heavens has been reproduced in each January number of **Sky and Telescope** beginning with 1942. From time to time additional items have been added to the chart, with a corresponding increase in astronomical information that can be gleaned from it. Let us analyze some of the features in detail.

Twilight Period. The beginning and ending of astronomical twilight are taken as the times when the sun's center is 18 degrees below the true horizon. Accordingly, the length of twilight is governed by the apparent speed with which the sun rises and falls when it is below the horizon. The vertical component of motion is a maximum when the sun is on the equator, independent of the observer's latitude, although the magnitude of this maximum rate does decrease with increasing latitude.

It can be seen that the twilight bands on the chart are narrowest for March and September, slightly wider in fall and winter, and appreciably wider in spring and summer. At lower latitudes, the variations in width would be much less, and at the equator, the duration of twilight in December would equal that in June. On the other hand, at higher latitudes, the increase in spring and summer would become preponderant and eventually merge into a single band of twilight that would last all night.

Change in Longitude. There would be no effect on the slopes of the curves on the Graphic Time Table if one were to redraw it for a different longitude at the same standard latitude (40° north). There would be merely a displacement that is of interest to investigate.

Actually, the sun rises and sets but once a day at any given station, so that a chart would suffice on which were plotted just the dots representing the daily local civil times of sunrise and sunset at the station. (Indeed, this is exactly what is done in the case of the moon.) Imagine following a parallel of latitude around the earth toward the west at such a rate that the sun's upper limb remained tangent to the horizon. The local civil time of sunset would change very slowly as the sun moved among the stars. As the observer completed one journey around the earth, the sun would be seen setting at the standard station one day later. In other words, an interval of one day on the Time Table is equivalent to 360 degrees of longitude.

Theoretically, for some other longitude, one should redraw the horizontal lines representing individual nights, interpolating them properly along the vertical time scale. Since the standard station is at 90° west, lines drawn midway between the daily lines on the chart would be accurate for 90° east. For 180° longitude, the interval would be one quarter of that to the following date, while for Greenwich it would be advanced a quarter of a day. Account would have to be taken of the International Date Line in labeling the chart.

By connecting the dots for moonrise or moonset and interpolating as above, one can see how longitude has an effect on lunar times that is quite appreciable, whereas the effect on other phenomena plotted (such as sunrise and sunset) is not very serious inasmuch as their curves are generally far from horizontal.

Lunar Phenomena. Times of Phases: The symbols show the phases and the times of rising and setting during the night. Close examination, however, will reveal additional information concerning the moon's distance from the earth and the positions of its nodes on the ecliptic.

The symbols for first and last quarter lie along a broken curve because they give the times of setting and rising, respectively, that are near that of the phase. Consider first quarter in February, estimating times to the nearest tenth of an hour. The **American Ephemeris** tabulates the time of first quarter as February 20, $17^h.7$ UT. The chart shows that on the standard meridian (longitude 90° west) at 40° latitude, the moon sets at February 21, $2^h.0$ local civil time. Adding six hours for longitude gives February 21, $8^h.0$ UT. Similarly, it sets at $6^h.9$ UT the day before. Interpolating the time of first quarter between these two hours at which the moon

(Continued on page 74)

REPRODUCED on the following pages is a chart published annually by the Maryland Academy of Sciences, through whose courtesy the engraving has been lent for our use. Separate copies may be obtained from the Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., for 25c each; on orders of 20 or more the price is 15c each. Large wall charts, 40 by 27 inches, are $1.00.

Using the Graphic Time Table

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets, the duration of twilight, times when certain stars and other objects of interest transit (cross the meridian), the moon's phases, the equation of time, and other astronomical information. Following the line for any day horizontally across the chart, one can read off the times of various events as the horizontal line intersects any of the curves. Time is shown by the vertical lines to the half hour, and more precise times may be determined by interpolation. The curve for the equation of time shows how much the sun is fast if the curve is to the left of the midnight line, and slow if it is to the right. When the sun is fast, it arrives at the meridian before 12 o'clock noon, local time, by the amount shown.

The dashes on the sunset and sunrise curves aid interpolation on intermediate days. Roman numerals show sidereal time at midnight. The vernal equinox transit line is shown; this indicates the exact civil or ordinary time of zero hours sidereal time. Small numbers at the left give the Julian day. Moon phases are indicated by the conventional symbols, as shown at the bottom of the chart. Small black circles show moonset for the first half of the lunar month, and small open circles show moonrise from full to new moon.

The scale at the right is for finding rising or setting times of other objects. Set dividers or a strip of paper from the index at the center of the scale to the object's declination, north or south (which must be known), and in the direction desired for either rising or setting. Measure this same distance along the midnight line of the chart beginning at the proper right ascension indicated by the Roman numerals. Should this end point fall outside the chart, add to or subtract from the right ascension 12 hours and reset the dividers using the end of the scale rather than the center index. Through the point established, draw a line parallel to the vernal equinox line on the chart. This will show the time of the rising or setting of the object.

How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets are absolutely correct for only one point on the earth's surface—for this chart: latitude 40° north and longitude 90° west. The observer may easily correct for his own position. Latitude differences have comparatively minor effect and may in general be disregarded in this country.

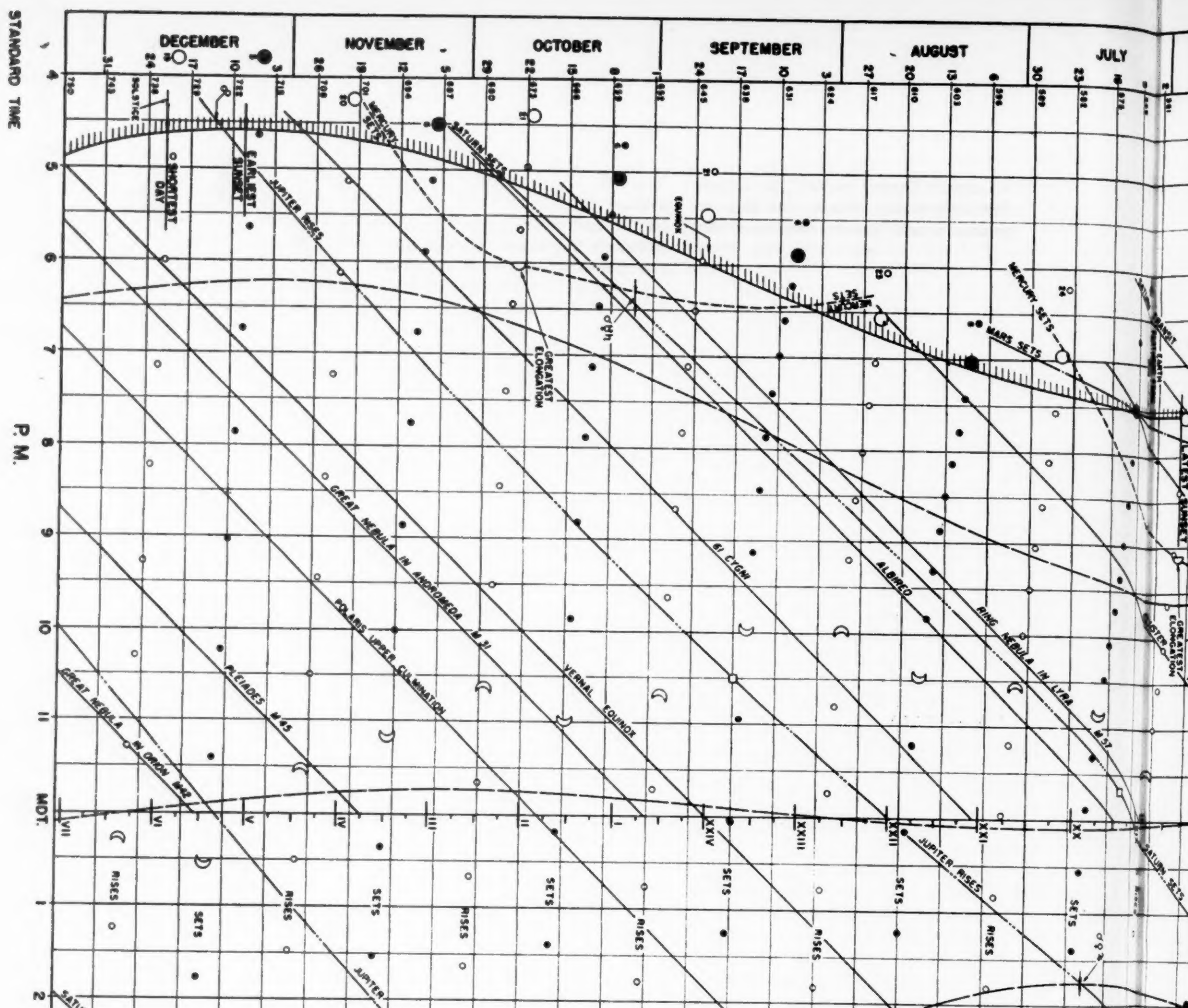
Correction for differences in longitude depends principally on the observer's distance east or west of his standard time meridian, which is always at an even multiple of 15°. Some corrections are tabulated here, in minutes of time:

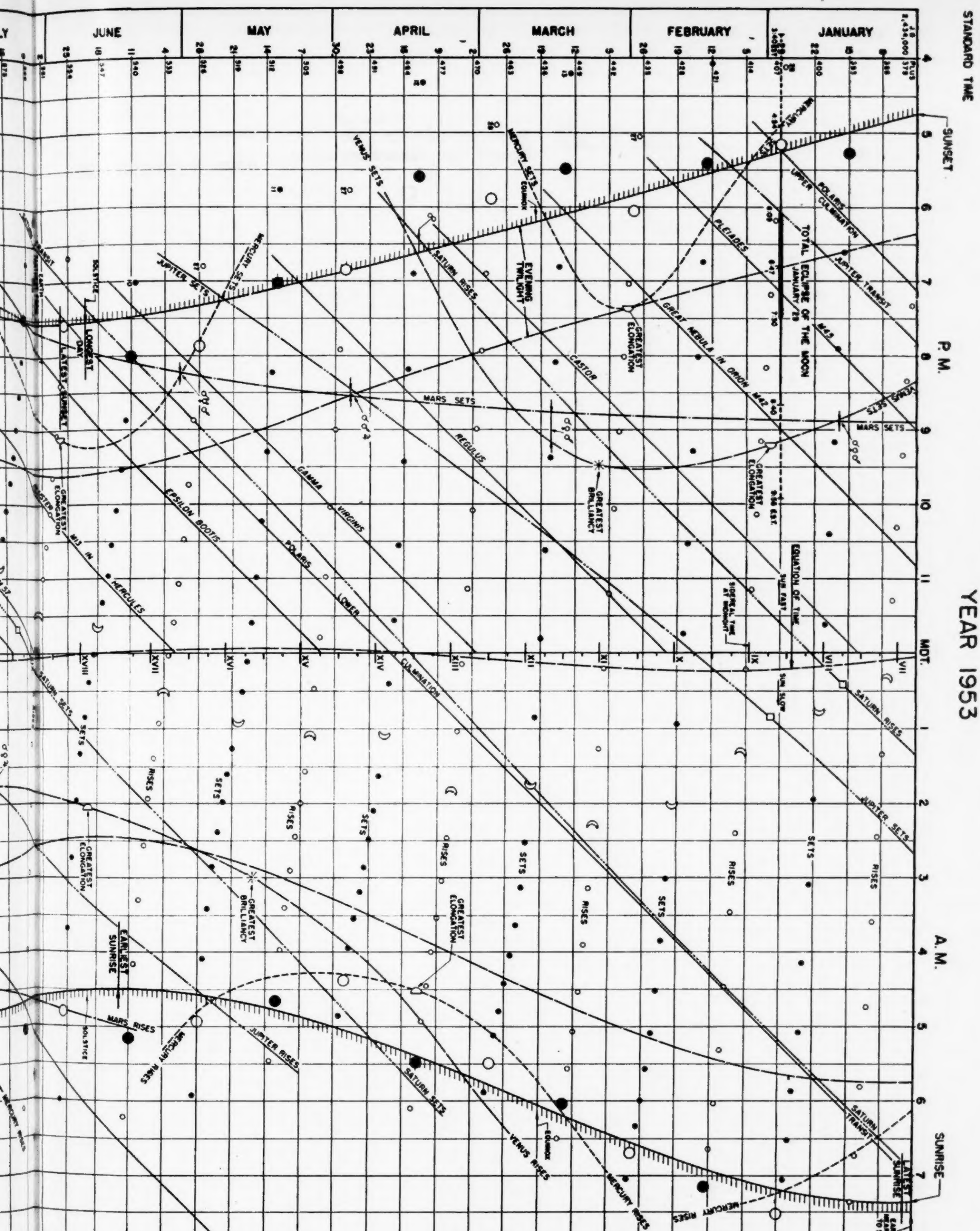
Atlanta +38	Kansas City +18
Baltimore +6	Los Angeles −7
Boston −16	Milwaukee −8
Chicago −10	Minneapolis +13
Cincinnati +38	New York −4
Cleveland +27	Pittsburgh +20
Denver 0	Rochester +10
Detroit +32	Seattle +10
Houston +22	St. Louis +1
Indianapolis −16	Washington +8

All places with plus corrections are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to the Eastern standard times given, and in the Far West slight corrections may be made to times of moonrise and moonset.

The Events of a Single Night

Consider the events of the night of January 8-9 by following the horizontal line for that date across the chart from left to right: the Julian Day number is 2,434,386; the sun sets at 4:52 p.m.; evening twilight ends at 6:28 p.m.; the upper culmination or transit of Polaris occurs at 6:38; Jupiter crosses the meridian at 7:22; the Pleiades, M45, transit at 8:31; Venus sets at 8:36; Mars sets at 8:53; the Great Nebula in Orion, M42, transits at 10:21; the curve for the equation of time indicates that the sun is slow, and will not arrive at the meridian until six minutes after 12 o'clock noon, local time, January 8; Saturn rises at 12:56 a.m.; the moon rises at 1:21 a.m. and it is one day past last quarter; Jupiter sets at 2:13; morning twilight begins at 5:45; Mercury rises at 6:28; Saturn crosses the meridian at 6:30; the lower culmination of Polaris occurs at 6:36; and the sun rises at 7:22 a.m.


STANDARD TIME
P.M.
A.M.
MDT.
DECEMBER
NOVEMBER
OCTOBER
SEPTEMBER
AUGUST
JULY
SOLSTICE
EQUINOX
SHORTEST DAY
EARLIEST SUNSET
LATEST SUNSET
MERCURY SETS
SATURN SETS
JUPITER RISES
MARS SETS
GREATEST ELONGATION
GREAT NEBULA IN ANDROMEDA M 31
POLARIS UPPER CULMINATION
PLEIADES M 45
GREAT NEBULA IN ORION M 42
VERNAL EQUINOX
61 CYGNI
ALBIREO
RING NEBULA IN LYRA M 57
RISES
SETS
JUPITER TRANSIT
SATURN RISES
MARS RISES
MORNING TWILIGHT
MERCURY RISES
JUPITER SETS
TRANSIT OF MERCURY
OCCULTATION OF ANTARES
TOTAL ECLIPSE OF THE MOON
JULY 26
(INVISIBLE EASTERN U.S.)
SYMBOLS:
NEW MOON
FIRST QUARTER
FULL MOON
LAST QUARTER
GREATEST ELONGATION
QUADRATURE
OPPOSITION
GREATEST BRILLIANCY (VENUS)
CONJUNCTION
MERCURY
VENUS
MARS
JUPITER
SATURN
© THE MARYLAND ACADEMY OF SCIENCES
SETTING
NORTH DECLINATION
SOUTH DECLINATION


THE MARYLAND ACADEMY OF SCIENCES
GRAPHIC TIME TABLE OF THE HEAVENS
YEAR 1953
STANDARD TIME
SUNSET
SUNRISE
P. M.
A. M.
MDT.
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
RISING
SOUTH DECLINATION
NORTH DECLINATION
TOTAL ECLIPSE OF THE MOON JANUARY 29
EQUATION OF TIME
SIDEREAL TIME AT MIDNIGHT
GREAT NEBULA IN ORION M42
PLEIADES
CASTOR
REGULUS
GAMMA VIRGINIS
EPSILON BOOTIS
M13 IN HERCULES
POLARIS UPPER CULMINATION
POLARIS LOWER CULMINATION
JUPITER TRANSIT
JUPITER SETS
JUPITER RISES
SATURN RISES
SATURN SETS
SATURN TRANSIT
MARS SETS
MARS RISES
MERCURY SETS
MERCURY RISES
VENUS SETS
VENUS RISES
EVENING TWILIGHT
GREATEST ELONGATION
GREATEST BRILLIANCY
EQUINOX
SOLSTICE
LONGEST DAY
LATEST SUNSET
EARLIEST SUNRISE
LATEST SUNRISE
EARTH NEAREST TO SUN
RISES
SETS

GRAPHIC TIME TABLE OF THE HEAVENS — 1953

(Continued from page 71)

sets at 90° west, one can find the approximate longitude and local civil time at which the moon is on the western horizon at the first-quarter phase. In this case it is about $1^h.4$ in longitude 115° east.

If this procedure be followed for each month and phase, the local civil times for any given phase will be found to lie along a smooth curve. Refraction, parallax, and lunar diameter combine to separate slightly the curves for first and last quarter and also those for new and full moon.

The curves for new and full moon follow generally those for sunrise and sunset. As a result of the inclination of the plane of the moon's orbit to that of the ecliptic, they oscillate about mean positions which are slightly to the left of the sunset curve and to the right of the sunrise curve. The reason for displacement of these mean positions is found in the solar diameter and atmospheric refraction. Thus it is possible to see the sun and moon on opposite horizons simultaneously during a lunar eclipse. A good example of this is shown in the case of the total eclipse on January 29. At the standard station, totality begins at 5:05 p.m. Central standard time, the moon rises about 5:10, and the sun sets about 5:15, as can be verified on the Time Table.

The Moon's Celestial Latitude: During the latter half of the year, it is obvious that full moon rises considerably before sunset and sets after sunrise, establishing the fact that the moon is full north of the ecliptic. Similarly, new moon is south of the ecliptic during the same months.

At first quarter, the moon sets after midnight during winter and spring but before it in summer and autumn. The rising of the moon at last quarter follows a similar pattern. Notice that the curves for rising and setting at the quarters cross the midnight line a little earlier than the dates of the summer and winter solstice. As a result, the first-quarter moon sets a little before midnight in June and hence must be south of the ecliptic at that time.

The Harvest Moon: The harvest moon occurs when the moon is full near the vernal equinox in the sky. The average situation finds this equinox on the eastern horizon, the winter solstice on the meridian, and the autumnal equinox on the western horizon. It is 18 hours by the sidereal clock. This orientation of the sky occurs at different times of day and night throughout the year. In order to represent these times on the chart, note the Roman numerals XVIII on the midnight line in June. Through this point, draw a line parallel to the one labeled VERNAL EQUINOX; call this the 18-hour line.

The phenomenon of the harvest moon is characterized by the small daily retardation of moonrise that occurs near the date of full moon in early fall. However, the same thing takes place at other phases at different seasons of the year, indeed at any time when the moon is near the vernal equinox. Notice that the line you have drawn passes through these regions of minimum daily retardation from March to September.

(To be concluded)

NEWS NOTES

By Dorrit Hoffleit

CHAUCER'S ASTRONOMY

"Equatorie of the Planetis" is the title of a 14th-century manuscript found in Peterhouse, Cambridge. Dr. Derek J. Price in *Nature* (September 20, 1952) describes it as a probable holograph by Geoffrey Chaucer. Besides his well-known poetry, which contains many astronomical allusions, Chaucer had written a treatise on the astrolabe in 1392, which is still recognized as the best work in the English language on the subject.

The "Equatorie of the Planetis" appears to have been an attempt at the popularization of a very difficult subject, and Dr. Price raises the question of whether the work with its frequent deletions may have been abandoned because the author found the necessary simplification he attempted too difficult or because he did not sufficiently comprehend his subject. In any case, Chaucer gives a good description of an early instrument for determining the position of the planets in the zodiac at any time; it "provides us with the only account in English of this device, and focuses attention on an important medieval astronomical instrument the very existence of which had been almost forgotten."

HARVARD RADIO TELESCOPE

The Agassiz station of Harvard College Observatory, located at Harvard, Mass., is in the process of installing a 25-foot equatorially mounted parabolic radio reflector for the purpose of studying the structure of the Milky Way. The antenna will be tunable to frequencies between 300 and 1,650 megacycles per second, including the 21-cm. hydrogen emission. Although the parabola will weigh 800 pounds, it is being built in one piece, consisting of an aluminum frame covered with aluminum mesh.

The new program has been aided by a $32,000 grant from the National Science Foundation and by an anonymous gift. It will be directed by Professor Bart J. Bok and Dr. Harold I. Ewen, a research associate at the observatory.

LUNAR PARALLAX

Nearly a decade ago the Swedish astronomer, Bertil Lindblad, advocating the use of eclipses for geodetic measurements, pointed out that the accuracy of the method depends on that with which the lunar distance is known. Hence, the Army Map Service undertook careful photoelectric observations of occultations in order to improve our knowledge of the lunar parallax. In a report in the *Astronomical Journal* (August, 1952), John A. O'Keefe and J. Pamelia Anderson arrive at three values, each depending on the theory of reduction of the observations and the measure of acceptance of the international ellipsoid for the shape of the earth. These results are near the previously accepted value for the moon's parallax, 3,422.682 seconds of arc.

NEW ASTROPHYSICS LABORATORY

A new laboratory of astrophysics and physical meteorology has been established at Johns Hopkins University. Its director is Dr. John D. Strong, well known as the man who developed a process for aluminizing telescope mirrors. It is his method that was adopted for aluminizing the 200-inch. The new laboratory will be devoted to the application of the results of experimental physics to the celestial sciences. Dr. Strong will continue in the production of the reflection gratings for which Dr. R. W. Wood made Johns Hopkins famous, according to the *Journal* of the Optical Society of America.

METEOR TRAIN STATISTICS

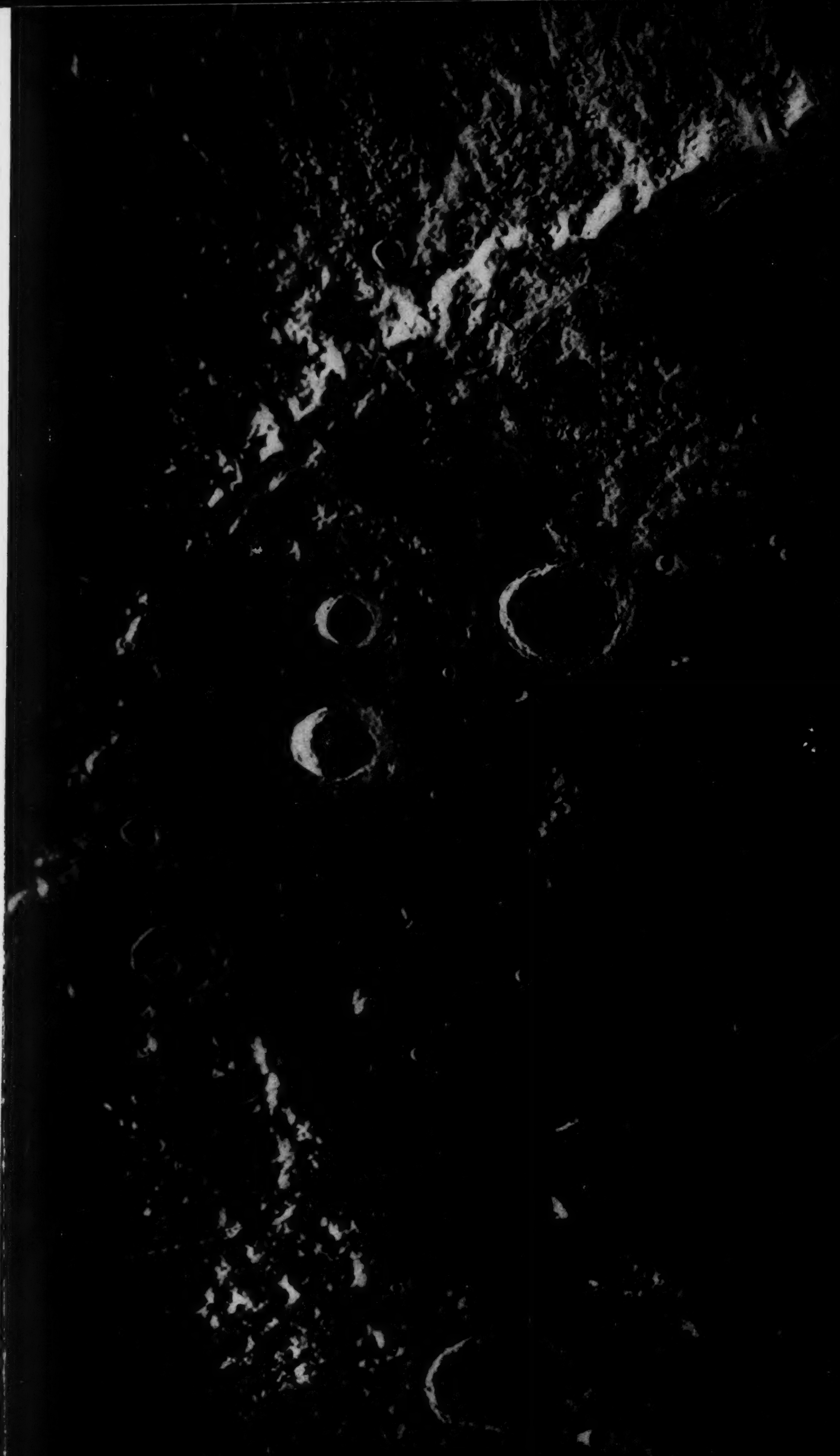
In two papers in the *Contributions* from the Astronomical Institute of the Charles University (Prague), Miroslav Plavec discusses some aspects of the statistics of meteor trains. As it has been known that showers seem to differ in the percentage of meteors leaving persistent trains, he examined data by experienced observers and found that the percentage depends on the geocentric velocity of the meteors. This is in fact reasonable. The trains are an ionization

IN THE CURRENT JOURNALS

OPTICAL PROBLEMS AT THE PALOMAR OBSERVATORY, by Ira S. Bowen, **Journal,** Optical Society of America, November, 1952. "In practically every case the performance has come up to the specifications and our hopes for it."

OZONE IN THE EARTH'S ATMOSPHERE, by G. M. B. Dobson, **Endeavour,** October, 1952. "Its strong absorption of both ultra-violet and infra-red radiation, for example, has important meteorological consequences which, however, cannot yet be fully appreciated owing to lack of detailed information about its variation from day to day. This deficiency, which also limits our appreciation of the importance of ozone in other respects, is about to be made good by means of regular daily measurements of atmospheric ozone at fifteen different stations in or near western Europe."

THE CARBON 14 METHOD OF AGE DETERMINATION, by J. Laurence Kulp, **Scientific Monthly,** November, 1952. "The method has produced highly significant results already, and its discovery may presage the greatest single advance in historical science."



ph
by
hig
mo
pat
but
Ge

the
the
hav
obs
Th
tua
lea
trai
194
cen
a n
the
sun
wh
age
som
one
teor
acce
Fut
of i

TE

O
nour
cove
of M
near
tion.
or U
ten's
pone
lianc
insta
becor
In J
avera
of th
Re
more
which
25ᵃ.4
nates
23rd,
Alleg
appea
nitud
than
Griffi
emplo
attach
been
ber 1
bright
scope.
about
sensiti
variat
comple
was c
made,
visible
star w

phenomenon in the atmosphere excited by the passage of the meteors. The higher the velocity of the meteor, the more ionization it produces along the path. Thus 50 per cent of the Perseids but only five per cent of the slower Geminids leave trains.

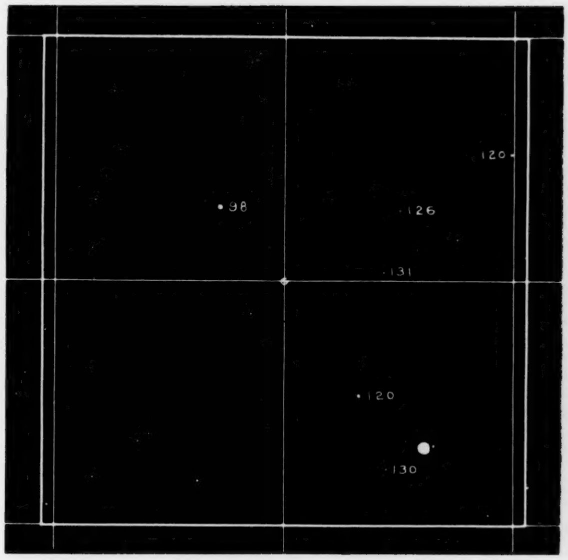
In the second paper Plavec studies the Perseid stream in greater detail. At the Skalnate Pleso Observatory records have been kept of 8,028 Perseid meteors observed from 1933 through 1947. There appears to be a year-to-year fluctuation in the percentage of meteors leaving trains. In 1933, 45 per cent left trains; in 1936 almost 60 per cent; in 1945, 35; and in 1947, with 53.5 per cent, the curve seemed again heading for a maximum. Plavec tried to correlate these figures with daily and monthly sunspot numbers, without success. But when he compared them with the average annual sunspot numbers he did find some correlation. Since little more than one sunspot cycle is covered by the meteor observations, he suggests caution in accepting the association as proven. Future work along these lines should be of interest.

TERRIFIC FLARES

On April 20, 1949, Harvard Announcement Card 990 reported the discovery by Dr. W. J. Luyten, University of Minnesota, on Harvard plates, of a nearby double star of large proper motion. It bears the designation L 726-8 or UV Ceti, but is generally called Luyten's flare star, because the fainter component bursts into extraordinary brilliance in an unpredictable manner. For instance, on December 7, 1948, it had become 12 times as bright as normal. In June, 1949, it was suggested that the average interval between flares might be of the order of at least half a day.

Recent announcement cards contain more reports of outbursts of UV Ceti, which is located at the position $1^h\ 36^m\ 25^s.4$, $-18°\ 12'\ 41''.7$ (1950 co-ordinates). On the morning of August 23rd, Dr. N. E. Wagman, director of Allegheny Observatory, observed what appears to have been at least a two-magnitude flare lasting probably no longer than about seven minutes. At the Griffith Observatory, Paul E. Roques, employing a photoelectric photometer attached to the 12-inch refractor, has been following the star. On September 17th at 9:40.3 UT he observed the brightening of the star in the telescope. Expecting a possible flare of about a magnitude, he had set the sensitivity of the photometer for such a variation. The flare threw the needle completely off the scale, however, and was over before adjustment could be made, in four minutes. Ordinarily invisible in the finder of the telescope, the star was conspicuous during the flare.

The Copenhagen announcement card service of the International Astronomical Union brings news of the greatest flare of all. V. Oskanjan, at the Belgrade Observatory, Yugoslavia, found the star at visual magnitude 12.3 or 12.4 for three quarters of an hour on the night of September 24-25. Then it brightened slowly to 11.6 by 1:00 UT, to 10.3 by 1:00.1, and suddenly all the way to 6.81 by 1:00.3, or an increase in brightness of 4.8 magnitudes in only 20 seconds! Four minutes later the star had begun to fade, frequent observations showing its steady decline back to 11.2 at 2:35 UT.



The central portion of an AAVSO "d" chart of UV Ceti, showing a region half a degree square and centered on the variable star. The magnitudes of certain nearby stars are marked to tenths with the decimal point omitted in each case. South is at the top and east at the right.

COLOR-MAGNITUDE DIAGRAMS AND STELLAR EVOLUTION

(Continued from page 65)

energy. There would then be another stage of expansion of the outer envelope with reduction of surface temperature, and so on.

Sandage and Schwarzschild have assumed that a typical globular cluster was formed 3,500 million years ago, at that time consisting of a mixture of stars having masses between one and $2\frac{1}{2}$ times the mass of the sun. They then computed for each mass the present location of the star on its evolutionary track and drew a heavy line through the points thus obtained. The result gave a synthetic color-magnitude diagram which possesses the principal features of the observationally constructed diagrams.

Incidentally, in the observational diagrams the upper horizontal branch, with blue stars and RR Lyrae variables at absolute magnitude 0, is not explained in this work. Stars that originally had such high absolute magnitudes must have long ago moved out of the entire range of the Sandage-Schwarzschild curves. What has happened to them we do not know. Perhaps they were never there to begin with. Or, if they did exist 3.5 billion years ago, they may have undergone the explosion processes of the novae in order to get rid of their excess masses and have settled down to quiet existences as "degenerate" white dwarfs.

We can now detect a certain amount of agreement in the diagrams of Populations I and II, whereas at first they seemed to be entirely different. In the first place, both contain the same lower branches of the main sequence, where the red dwarfs are located. This means that stars of very low temperature and luminosity remain practically the same for many billions of years. The more luminous stars have evolved differently in the two populations. In the globular clusters they were formed about 3.5 billion years ago by some process of condensation which left no gaseous or dust-like medium behind. Once these stars were formed they were on their own, and their evolution followed the Sandage-Schwarzschild tracks.

In Population I we observe stars of all ages. Some were probably formed three or four billion years ago. Others could not have been what they are now much longer than one million years. Since there is even now a large amount of gas and dust in the spiral arms of our galaxy, these Population I stars can grow by accretion (or become rejuvenated, to use von Weizsaecker's expression) or they can perhaps even now be formed out of globules of interstellar matter. The galactic or open clusters must be relatively recent formations. This agrees with the ideas of V. Ambarzumian on the expansion of stellar associations, and it finds support in A. Blaauw's investigations of the motions in the clusters near Xi Persei and in the Lacerta region.

BOOKS AND THE SKY

PICTORIAL ASTRONOMY

Dinsmore Alter and Clarence Cleminshaw. Thomas Y. Crowell Co., New York, 1952. 296 pages. $4.50.

WHEN was the star Arcturus nearest to the sun? What will the famed Southern Cross look like in 10,000 years? What are the five most luminous and the two least luminous stars in our galaxy? Which eclipsing binary system has the shortest period?

The answers to these and hundreds of similar questions may be found in **Pictorial Astronomy,** written by two well-known authors.

The book is not intended to be a text; however, the presentation of the material is such that it could be so used, particularly for the teaching of younger students. The book gives careful attention to topics that are of present-day interest to the average American. The writers do a magnificent job of presentation to a varied group of readers, for they, being lecturers in a modern planetarium, are acquainted with the many questions and lines of inquiry of the American public.

The book is divided into eight sections: The Sun; The Earth; The Moon; Eclipses: The Planets; Comets and Meteorites; Stars and Nebulae; and Miscellaneous. Each section is further divided into chapters, all packed with useful information, accompanied by numerous charts and diagrams to help make the text clear. There are many photographs with explanatory captions, all excellently reproduced.

One of the best methods of acquainting you with the type of material in the book is to mention a few of the chapters that to me seemed outstanding, for the material in them and for the new manner of presentation, plus the fact that many valuable statistics are given.

One such is "The Sun's Daily Path Across the Sky." This is accompanied by two charts, and gives a very real picture of the reasons behind the physical nature of seasonal changes. The approach is both new and informative to the reader.

"Foretelling Eclipses by Simple Methods" will appeal to many of those who like computation exercises, not difficult, but merely the application of addition and subtraction for the making of predictions.

Many of us, who were born in this century, have longed to see a great comet, of the kind that relatively speaking seemed plentiful in the 1800's. "Great Comets of the Past" encourages our thinking along these lines, for the descriptions of comets such as those that appeared in 1811, 1843, and 1882, are rich and accompanied by statistics that give the reader the tangible data necessary for a mind picture of what a great comet must appear to be.

The same rich portrayal is given to "Facts about Some Notable Stars," wherein the authors describe in statistical terms such famous friends as Arcturus, Betelgeuse, Altair, and Acrux. The reader is carefully guided through distances, temperatures, proper motion, surface area as related to brilliance and to comparison with solar radiation, yet the reader doesn't feel as if he had swallowed a mathematical pill too large for him.

"The Visit of Arcturus to the Sun" is another of the highlights of the book. This gives the reader the idea of a dynamic universe, the conception of an ever-changing sky, and though time eras are in terms of hundreds of thousands of years, one can picture the changes that must occur in such epochs.

Many of us have at one time or another given thought to what our day or night would appear to be, were we in the midst of one of the large globular clusters of our galaxy. "The World of the Hercules Cluster" puts into realistic words the dreams of all of us on this thought. I quote: "Usually there might be two dozen stars brighter than Venus scattered over the sky. Stars like Vega and Arcturus would seem to be dwarfed to insignificance, for thousands of such would be visible. There would be a splendor to the sky so far surpassing our own as to be almost unimaginable."

One of the fundamental concepts of astronomy is the period-luminosity law of the Cepheid variable. What we know of the remote distances in our galaxy and of some of the distances of the extragalactic systems is based on this law. Its history is associated with the study of the Magellanic Clouds. A separate chapter

NEW BOOKS RECEIVED

THE HISTORY OF ASTRONOMY, *Giorgio Abetti*, 1952, *Schuman*. 338 pages. $6.00.

A discussion of astronomy from the most ancient times to the work of 20th-century investigators. The book is a translation by Betty Burr Abetti of the Italian *Storia dell' Astronomia*, and is published in this country as one of the volumes in the Life of Science Library.

STARS IN THE MAKING, *Cecilia Payne-Gaposchkin*, 1952, *Harvard University Press*. 160 pages and 67 plates. $4.25.

A new volume in the Harvard Books on Astronomy series presents an up-to-date picture of the problem of stellar evolution, with particular attention to the observational facts now known. The author discusses, in popular language, the stars, dust and atoms of which the universe is composed, then the problems of the pairs, clusters, and systems of stars as we know them. She concludes with chapters on the evolution of galaxies and the evolution of the stars.

THE UNIVERSE WE LIVE IN, *John Robinson*, 1952, *Crowell*. 252 pages. $4.50.

This book takes the layman on a guided tour of our universe, discussing some of the facts and problems of astronomy, and also something of the earth's history and present situation, geologically speaking.

SUN, MOON, AND PLANETS, *Roy K. Marshall*, 1952, *Holt*. 129 pages. $2.50.

A popular account of our solar system and the bodies in it, designed to answer the many typical questions about astronomy such as are asked by visitors at planetarium demonstrations.

OUR NEIGHBOUR WORLDS, *V. A. Firsoff*, 1952, *Hutchinson's*, London. 336 pages. 25s.

A discussion of astronomical facts about the solar system woven together with an investigation of the problems of space flight, written in popular style, and with some detailed mathematical discussions in the appendix.

tells the story of these objects, along with sizes, distances, and their position relative to our galaxy. To most of us who have spent all of our lives in a section of the world from which the Clouds are invisible, this chapter is intensely interesting.

There are five tables of data—solar, terrestrial, lunar, planetary, and stellar. Each is most complete. Until now one had to peruse four or five books to obtain this and other valuable statistical data now under one cover.

"How to Recognize the Stars" and "The Sky from Pole to Pole" give descriptions and directions, together with maps for the most important constellations.

The great merit of Pictorial Astronomy lies in its presentation of the basic fundamentals and concepts of astronomy in a simple yet descriptive and appealing manner.

JAMES H. KARLE
Lewis and Clark College

PROCEEDINGS OF THE LONDON CONFERENCE ON OPTICAL INSTRUMENTS — 1950

John Wiley and Sons, New York, 1952. 264 pages. $7.00.

DEVELOPMENTS in the field of optical instruments have been numerous and significant in recent years. We need mention only phase contrast microscopy, catadioptric systems, and improved instruments and tools for spectroscopy to indicate how far-reaching have been the effects of work in the past quarter century.

Credit is due the British subcommittee for optics for arranging the London conference in 1950, which was attended by scientists from all over the world. The range of topics was necessarily limited to those of outstanding interest. The subjects selected as most worthy of attention at the conference were photographic lenses, reflecting microscopes, diffraction gratings, phase contrast microscopes, spectrophotometers, reflecting telescopes, and new optical materials.

The book, containing the contents and presenting the scope of the conference itself, is not intended for any particular group of readers. Those who have kept pace with optical developments (if that is possible) will not find any important material that has not been reported in the usual periodicals. But others may read here reports by recognized leaders which will help bring them up to date in optical instrumentation. In most cases, the authors discuss particular instruments or developments in detail, and do not survey the field in general. This may be either good or bad, depending upon the attitude and interests of the reader.

Of the 21 papers reproduced, 18 are in English, two in French (with English summaries), and one paper consists of a summary only. Most of the authors have furnished adequate bibliographies—the reviewer wishes that all had taken the pains to do so.

This book probably belongs on the shelf of everyone who pretends to keep up with current developments in optical instruments.

EARLE B. BROWN

SUN, MOON, AND PLANETS

Roy K. Marshall. Henry Holt and Co., New York, 1952. 129 pages. $2.50.

MORE AMERICANS see and hear Roy K. Marshall than all the other astronomical scientists put together. His informative "commercials" on the Ford TV program and his own famous "The Nature of Things" are received in several million homes. Most of the viewers are unaware that the versatile author of **Sun, Moon, and Planets** is basically an astronomer who returns here to his field of special study.

Long a regular contributor to **Sky and Telescope,** which printed his fascinating Astronomical Anecdotes, Dr. Marshall is in this book writing a modest volume on the solar system. The audience addressed is one-half cut above his vast TV audience. It may well be that this new book is the fastest reading of any on the subject that pretends to get the facts across.

Expert at finding striking similes that stay with the reader long after the facts have faded, Dr. Marshall creates sharp pictures of the members of the sun's family, without losing sight of the scale of things and the emptiness of space. In addition to the word pictures, there are a number of line illustrations drawn by the author.

Just to mention one of 16 chapters at random, "Our Star, the Sun" is only 1,800 words long and has no illustrations, but it is an extremely lucid description. It is characteristic of the special merit of this companion to the earlier Henry Holt book, **The Nature of Things.** We hope that it will be soon followed by another volume on astronomy that Dr. Marshall has in mind.

J. W. STREETER
Fels Planetarium

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A Simple Spectroscope for Solar Prominence Observations

During 1951, this department carried a series of articles by Richard B. Dunn in which he described the construction of a quartz monochromator, a most powerful instrument for observing various solar phenomena, especially the prominences. For those observers with mechanical ability and great patience, the construction of such an instrument is a worthwhile investment in time and money. However, there are those of us who do not have the time nor the necessary practical optical experience to undertake such a task, and yet we would like to see just what these prominences look like with our own telescopes. In this case a simple instrument such as the one described below will nicely fill the bill, and at a very moderate cost. And with a simple spectroscope we may have the thrill of repeating the same experiment first performed independently by Janssen and Lockyer in 1868, which marked the first time that solar prominences were seen without the aid of a solar eclipse.

C. A. Young in his book, **The Sun,** gives a good historical and technical background of spectroscopic observations of prominences, and for those who have access to the book, the chapters on the spectroscope and on solar prominences are strongly recommended.

For our purposes, a grating spectroscope is required to obtain the necessary dispersion for the size of instrument being considered. A reflecting grating type was finally built by the writer, although a transmission grating would also have worked. It is, however, not feasible to use a single-prism instrument, because of the low dispersion in the red portion of the spectrum, where most of the solar observations will be made.

Constructing the spectroscope. The author was very fortunate in being able to borrow two small laboratory-type telescopes, a simple slit, and a good replica reflection grating from the physics department of South Dakota State College, where he was then (1949) a student. The only problem was to mount the components suitably.

The first photograph gives an over-all view of the instrument, which is to be attached to the eye end of the main telescope. The framework consists of two pieces of strap iron riveted to a circular plate such that the longitudinal axes of the strap iron pass through the center of the plate. The view telescope and collimator are strapped to V-block assemblies which are in turn bolted to the framework. A V cut was made in the upper block in each assembly, two matching holes were drilled through the upper and lower blocks, and the holes in the lower block were tapped. In addition, a hole was drilled in the center of each lower block in order that it could be bolted to the framework. The two blocks in each assembly are held apart by compression springs which allow for vertical adjustments of the collimator and view telescope.

After the spectroscope was attached to the main telescope, it was found that the strap-iron framework was not strong enough, and two pieces of aluminum pipe were welded together at the 37-degree angle of the framework, and then bolted to the strap iron. This solved all difficulties.

The second photograph gives a close-up view of the grating table. This table is composed of a second plate of the same diameter as the base plate. A long bolt was soldered to the center of the upper disk, and this passes through a hole in the center of the lower plate. A compression spring was inserted between the nut and the lower plate, thus tending to hold the upper and lower plates together. The disks are held apart by three symmetrically placed bolts which pass through nuts soldered to the bottom disk. These bolts allow for the necessary adjustments of the height of the grating table.

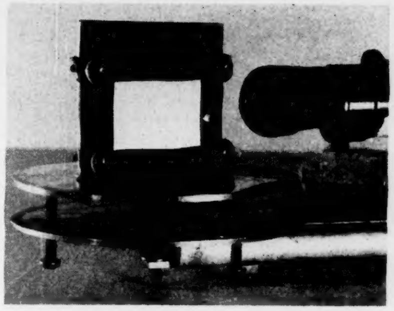
A piece of brass with a lip bent at right angles is bolted to the top plate and supports the grating. It is important that this plate be exactly perpendicular to the

The spectroscope constructed by Harold Leinbach was fitted with an adapter tube for a 5-inch refractor. A weight of several pounds was attached to the objective end of the telescope to counterbalance the spectroscope.

grating table, as the grating plane must be perpendicular to the plane of the optical axes, for proper adjustment of the instrument.

The two telescopes used in the spectroscope have achromatic objectives of one-inch aperture with a focal length of about 11 inches. Of course, the eyepiece of one telescope is removed so that it can be used for the collimator. The slit is the type sometimes used in elementary optical experiments, and works on the parallelogram principle. Since the slit mounting is bolted directly to the frame of this instrument, it is necessary to slide the collimator back and forth in the V-blocks in order to focus the slit. This construction was chosen for the sake of convenience only. A first-class instrument would have the slit as an integral part of the collimator, in order to do away with any possible stray light, such as might be encountered using the construction described.

Adjusting the spectroscope. An excellent description of how to adjust this type of spectroscope for prominence observations can be found in Young's book. The basic steps for properly adjusting the instrument are:



The mounting for the grating.

1. The view telescope and collimator axes must be coplanar, and this plane must be perpendicular to the plane of the grating. These adjustments are made by suitably changing the heights of the V-blocks, and by adjusting the leveling screws on the grating table.

2. The slit must be in the infinity focal plane of the collimator. This adjustment may be made as follows: Remove the grating table and the view telescope. Focus the telescope for infinity by viewing a distant object. Now look at the objective end of the collimator with the focused telescope, making sure that the optical axes of the collimator and telescope coincide. Now focus the slit (which entails moving the collimator back and forth in the instrument described here) until the slit appears as a sharp line. It is apparent that when this condition is fulfilled the light emerging from the collimator is parallel.

3. The direction of the slit must be parallel to the lines of the grating and these lines in turn must be perpendicular to the plane of the optical axes. If the spectrum appears to be curved as the grating is rotated, the grating is not perpendicular to the plane of the optical axes. If the spectrum has an upward or downward motion as the grating is rotated, the lines on the grating are not perpendicular to the optical axes of the system.

Using the spectroscope for prominence observations. The visible disk of the sun is known as the photosphere. Above the photosphere lies a cooler layer of gas, the so-called reversing layer, and, in turn, above this region is the chromosphere. When we view the disk of the sun with a spectroscope, we see a continuous spectrum interrupted by a multitude of dark absorption lines, the Fraunhofer lines. However, if we view the very edge of the sun, we see not only many Fraunhofer lines, but we also see that some of the Fraunhofer lines have been replaced by bright emission lines. An important set of these emission lines is the Balmer series of hydrogen. Of these lines, we are particularly interested in the red H-alpha line, which has a wave length of 6563 angstrom units.

The spectrum is really nothing more than an infinite number of images of the slit. The H-alpha line then is one of these images, and hence, if the slit is unevenly illuminated as it would be if we were looking at a prominence, we would expect that the spectral line would also be unevenly illuminated, and such is the case. If we now open the slit little by little, we

are taking in more and more of the image of the prominence, and hence the prominence will begin to take shape in the widening H-alpha line. Unfortunately a width is soon reached where the increasing background light obscures the image of the prominence. Thus, there is a limit to which we can open the slit. This means that if we are using a large image of the sun, certain prominences may be too big to include in the widened H-alpha line, and we will then have to build up a mental image of them while scanning the limb of the sun.

The spectroscope is effective in showing us the prominences because it tends to reduce the solar continuum by dispersion without materially decreasing the monochromatic light from the prominence. With a grating instrument, especially when the second-order H-alpha line is used, it will be necessary to place a red filter in the optical train of the telescope in order to cut out all scattered light of other colors, and particularly to cut out the overlapping third-order violet spectrum.

The author's spectroscope was used with a 5-inch f/15 refractor diaphragmed to 4¼", the spectroscope being attached to the eyepiece adapter tube of the telescope. With the 2" image size used, it was found that prominences of the order of 50,000 miles in height could be seen in their entirety, with fair contrast with the background light. However, very large prominences could only be seen by allowing the image to drift across the slit. Since observations are best made with the slit tangential to the limb of the sun, the spectroscope must be rotated in order to view different sections of the solar limb.

In addition to the prominences in the red H-alpha line, brighter ones may be seen in the blue-green H-beta line at 4861 angstroms. The very brightest could even be seen in the helium D_3 line, at 5876 angstroms, which lies close to the well-known sodium doublet in the yellow portion of the spectrum.

This simple spectroscope is not adaptable for taking photographs of solar prominences. For that work a spectroheliograph is needed, or better still, a quartz monochromator. The monochromator is also an ideal visual instrument, because extraneous scattered light is almost nonexistent, and there is no distortion of the image. Hence, contrast is high and very fine detail can be seen. On the other hand, the spectroscope can be used to view the entire visible spectrum.

The serious solar observer dreams of the day when he has his own monochromator, but until then, and for the more casual amateur, the simple spectroscope does afford a way by which to observe one of the most fascinating of all celestial phenomena, the solar prominences.

HAROLD LEINBACH
Geophysical Institute
University of Alaska
College, Alaska

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

UNITRON Leads in Value and Quality

The Choice of Leading Universities and Active Amateurs the World Over

The refractors that all astronomers are talking about! Precision made from the finest of materials by one of the world's largest manufacturers of optical instruments.

1.6-INCH ALTAZIMUTH

A wonderful instrument for the beginner and young people interested in astronomy.

UNITRON Model 127

Objective: 42-mm. (1.6") diam., 700-mm. (27.5") focal length, f/17.5.
Eyepieces: 78x, 56x, and 39x included. 100x: $8.95 extra.

COMPLETE with tripod and altazimuth mounting, slow-motion controls for both altitude and azimuth, view finder, star diagonal, sunglass, eyepieces, wooden cabinet. Only $75

2.4-INCH ALTAZIMUTH

UNITRON Model 114

Not illustrated. Same optical specifications, eyepieces, and accessories as the 2.4-inch Equatorial, but with altazimuth instead of equatorial mounting.

COMPLETE with tripod and altazimuth mounting, slow-motion controls for both altitude and azimuth, view finder, star diagonal, sunglass, eyepieces, wooden cabinets. Only $125

ACCESSORIES and COMPONENTS

will be made available separately as fast as conditions permit. These will include equatorial mountings, optical components, sun projecting screen, an astro-camera, and the 10 x 40 mm. view finder and 62-mm. guide telescope supplied with Model 145.

We welcome your inquiries.

They will receive immediate, personal, and careful attention. We will send you at no cost or obligation illustrated literature and actual photographs of the telescopes. You will learn of some of the distinguished institutions which have selected UNITRON Refractors for their observatories, and what buyers of these telescopes have reported as to their quality and performance.

Please address your card or letter to the attention of Dept. TA-1.

Microscope catalogue also available.

- LENSES are FULLY CORRECTED for spherical and chromatic aberration and are COATED for maximum brilliance and clarity of image. AIR-SPACED CELL insures freedom from "clouding" with age.
- EYEPIECES of the HIGHEST QUALITY . . . Orthoscopic, Achromatized Ramsden, Huygens.
- FINEST MATERIALS throughout. DURALUMINUM TUBE. Moving parts of BRASS carefully machined to close tolerances, and finished in CHROMIUM.
- MODERN DESIGN based on time-tested engineering principles. HANDSOME APPEARANCE to which no illustrations can do justice.
- STURDY TRIPOD may be folded for convenient storage.
- EQUATORIAL MODELS have slow-motion controls for **both** declination and right ascension.
- ALTAZIMUTH MODELS have slow-motion controls for **both** altitude and azimuth.
- VIEW FINDER with crosshair eyepiece gives wide field of view.
- RACK-AND-PINION FOCUSING.
- STAR DIAGONAL for convenience in observing at all altitudes.
- SUNGLASS for solar observation.
- ERECTING PRISM SYSTEM for TERRESTRIAL OBSERVATION may be used with **any** of the eyepieces to give the **same** complete range of terrestrial magnifications as for celestial observation.
- FITTED WOODEN CABINET, handsomely finished, for compact storage of telescope and accessories. Separate case for the tripod.

Coming Soon!

3-INCH PHOTOGRAPHIC EQUATORIAL

For visual observations and astrophotography.

UNITRON Model 145

Main Telescope: 78-mm. (3") diam., 1,200-mm. (47.2") focal length, f/16. Furnished with eyepieces for 200x, 133x, 96x, 67x, 45x. 171x eyepiece also available.
Photographic Guide Telescope: 62-mm. (2.4") diam., 700-mm. (27.5") focal length. Furnished with 78x crosshair eyepiece.
View finder: 42-mm. (1.65") diam., 10 power.

COMPLETE with equatorial mounting and slow-motion controls, tripod, setting circles and verniers, sun projecting screen, sunglass, star diagonal, erecting prism system, eyepieces, pocket eyepiece case, wooden cabinets.

Write for photo and preliminary announcement.

Unbelievably low prices! Outstanding features, performance, and workmanship impossible to duplicate even by paying considerably more.

2.4-INCH EQUATORIAL

The complete instrument for the active amateur.

UNITRON Model 128

Objective: 62-mm. (2.4") diam., 900-mm. (35.5") focal length, f/15.
Eyepieces: 100x, 50x, 35x included.
150x: $14.75 extra.
129x: $8.95 extra.
72x: $6.75 extra.

COMPLETE with equatorial mounting and slow-motion controls, tripod, view finder, star diagonal, erecting prism system, sunglass, eyepieces, wooden cabinets. Only $225

3-INCH EQUATORIAL

Ideal for amateur research and school observatories.

UNITRON Model 142

Not illustrated. Identical to Model 145 but without the 62-mm. guide telescope and with a smaller (21-mm.) view finder.
Eyepieces: 200x, 133x, 96x, 67x, 45x included. 171x: $8.95 extra.

COMPLETE with equatorial mounting and slow-motion controls, tripod, setting circles and verniers, sun projecting screen, sunglass, star diagonal, erecting prism system, eyepieces, pocket eyepiece case, wooden cabinets. Only $435

4-INCH EQUATORIAL

The 4-inch refractor has been awaited with great interest and is soon to be announced. Upon request, we shall be happy to forward advance information as soon as it becomes available.

All Instruments Are Fully Guaranteed

Send check or money order for full amount or 25% deposit with balance C. O. D.
Telescopes shipped Express Collect.

UNITED SCIENTIFIC CO. 204-6 MILK ST. BOSTON 9, MASS.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

THE TOTAL LUNAR ECLIPSE OF JANUARY 29TH

FIVE ECLIPSES occur in 1953, three of the sun and two of the moon. The solar eclipses are partial and are generally of little interest; the lunar eclipses are total, the first occurring on January 29-30, the second on July 26th.

Observers in the United States and Canada may observe the moon immersed in the earth's shadow when it is at the full phase this month. On the evening of January 29th, along the East Coast, the moon will rise partially eclipsed, totality beginning at about 6:05 p.m. EST. In the Middle West, the beginning of totality and moonrise oçcur very close together. The moon will still be partially darkened when it rises in the Far West.

From the **American Ephemeris and Nautical Almanac,** the times of the eclipse are (all p.m. January 29th):

Event	EST	CST	PST
Moon enters penumbra	3:40.1	2:40.1	0:40.1
Moon enters umbra	4:54.1	3:54.1	1:54.1
Total eclipse begins	6:04.6	5:04.6	3:04.6
Middle of eclipse	6:47.3	5:47.3	3:47.3
Total eclipse ends	7:29.9	6:29.9	4:29.9
Moon leaves umbra	8:40.4	7:40.4	5:40.4
Moon leaves penumbra	9:54.5	8:54.5	6:54.5

The moon will be close to apogee, presenting a disk about 29′ 34″ in diameter. Its slow motion in this part of its orbit results in an eclipse with a total duration of over six hours, including the penumbral phases. The magnitude of totality is 1.34, the moon's diameter being taken as 1.0.

This eclipse presents an unusually favorable opportunity to watch a totally or partially eclipsed moon rising in the east while the sun still appears above the horizon in the west. Refraction lifts each of these bodies more than its own apparent diameter when it is on the horizon.

Occultations of several stars of the 6th magnitude will be observable in the eastern and central parts of the country during the eclipse. Predictions for these are given on page 84. The dimming of the moon's light when it is in the earth's shadow will enable even the most casual observer to try his hand at timing occultations. The moon may also occult some stars fainter than these.

MOON PHASES AND DISTANCE

Last quarter	January	8, 10:09
New moon	January	15, 14:08
First quarter	January	22, 5:43
Full moon	January	29, 23:44
Last quarter	February	7, 4:09

	January	Distance	Diameter
Apogee	4, 22^h	251,800 mi.	29′ 29″
Perigee	16, 23^h	223,200 mi.	33′ 11″
	February		
Apogee	1, 12^h	252,300 mi.	29′ 25″

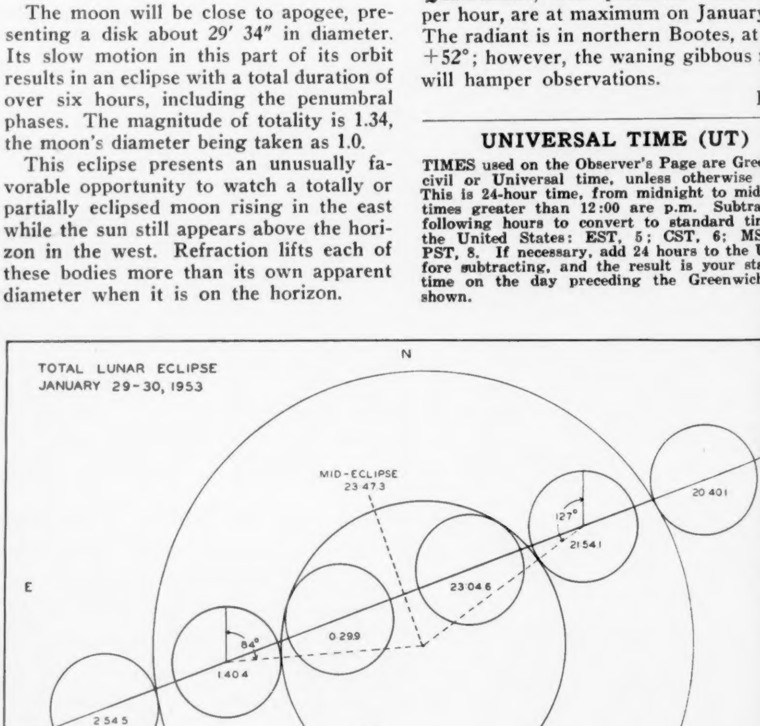
JANUARY METEORS

One of the better displays of the year occurs the first five days of January. The Quadrantids, with predicted rates of 40 per hour, are at maximum on January 3rd. The radiant is in northern Bootes, at 230°, +52°; however, the waning gibbous moon will hamper observations.

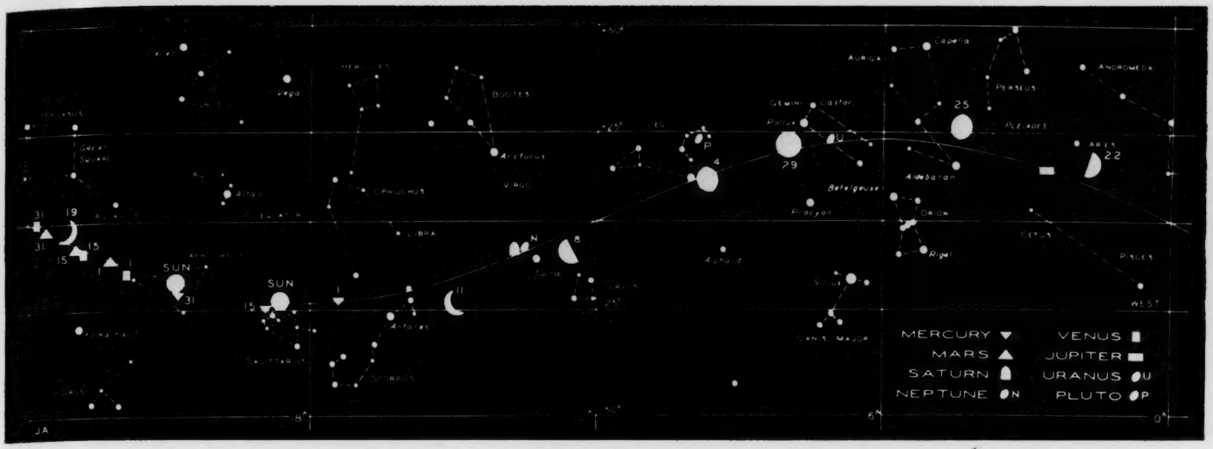
E. O.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.



A cross-section of the umbra and penumbra of the earth's shadow, showing positions of the moon during the eclipse of January 29th. Total eclipse occurs while the moon is in the umbra, from 23:04.6 to 0:29.9. The position angles on the moon (measured from north through east) are given for the points of first and last contacts with the umbra.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury is nearing the sun in the morning sky, poorly situated for observing.

Venus continues to attain greater prominence in the evening sky. Maximum elongation occurs on January 31st, 46° 54′ east of the sun in longitude, when Venus will remain visible four hours after sunset, shining at magnitude −4.0. Telescopically, the planet appears at quarter phase, presenting a disk 24″ in diameter.

Mars is in Aquarius and close to Venus all month. Appearing at magnitude +1.3 on the 15th, the ruddy planet continues in eastward motion. An interesting conjunction takes place on January 18th at 2:00 UT, visible on the evening of the 17th from the United States, when Venus will pass 12′ north of Mars. The following evening the crescent moon will be 4° north of the pair. Mars will be of little interest during 1953.

Jupiter appears on the meridian during twilight and is above the horizon until after midnight. It resumes eastward motion on the 5th, in Aries. The planet remains a brilliant object, at magnitude −2.1 on January 15th. The Jovian disk is 43″ in equatorial diameter on the 15th, a fine object for a small telescope.

Saturn rises about midnight, as it reaches western quadrature with the sun on January 17th. The ringed planet is located in Virgo to the east of Spica, slightly outshining the star. The famed ring system is inclined 14°.6 to our line of sight on the 15th, the northern face visible.

Uranus passes opposition to the sun on the 7th; hence it is visible all night. This 6th-magnitude object is traveling in central Gemini, north of Zeta and Delta. Its position on the 7th is 7^h 11^m.8, +22° 52′.

Neptune is a morning sky object in Virgo located about 4° north of Spica. Western quadrature takes place on January 14th, and retrograde motion commences on the 25th. Neptune's position on the 15th is 13^h 30^m.8, −7° 42′.

E. O.

SUNSPOT NUMBERS

October **1**, 17, 20; **2**, 20, 23; **3**, 22, 22; **4**, 33, 42; **5**, 34, 33; **6**, 41, 37; **7**, 25, 37; **8**, 23, 23; **9**, 17, 26; **10**, 16, 24; **11**, 15, 16; **12**, 17, 15; **13**, 16, 15; **14**, 15, 14; **15**, 13, 11; **16**, 9, 10; **17**, 0, 0; **18**, 0, 0; **19**, 14, 8; **20**, 18, 15; **21**, 21, 25; **22**, 25, 27; **23**, 29, 35; **24**, 28, 33; **25**, 34, 37; **26**, 40, 40; **27**, 38, 34; **28**, 36, 33; **29**, 33, 32; **30**, 30, 26; **31**, 20, 22. Means for October: 22.5 American; 23.7 Zurich.

Daily values of the observed mean relative sunspot numbers are given above. The first are the American numbers computed by Neal J. Heines from Solar Division observations; the second are the Zurich Observatory numbers.

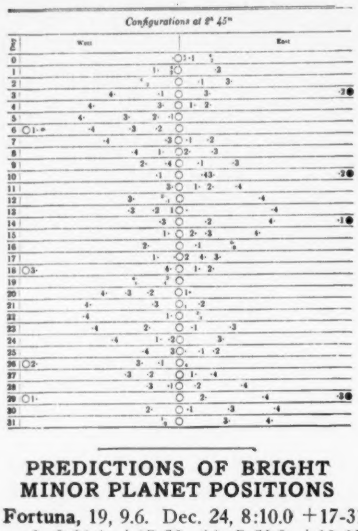
VARIABLE STAR MAXIMA

January 1, U Ceti, 022813, 7.5; 1, T Ursae Majoris, 123160, 7.9; 10, Chi Cygni, 194632, 5.3; 10, RS Cygni, 200938, 7.4; 19, R Canum Venaticorum, 134440, 7.7; 30, S Pegasi, 231508, 8.0. February 3, R Caeli, **043738**, 8.0; 5, U Herculis, 162119, 7.6; 6, T Herculis, 180531, 8.0; 6, R Indi, **222867**, 8.0; 7, RV Sagittarii, 182133, 7.8.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the **American Ephemeris and Nautical Almanac.**



PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Fortuna, 19, 9.6. Dec. 24, 8:10.0 +17-31. Jan. 3, 8:01.1 +17-52; 13, 7:50.8 +18-18; 23, 7:40.3 +18-46. Feb. 2, 7:31.0 +19-12; 12, 7:24.1 +19-32.

Bamberga, 324, 9.7. Dec. 24, 8:25.6 +30-39. Jan. 3, 8:14.9 +30-54; 13, 8:02.5 +30-55; 23, 7:50.0 +30-43. Feb. 2, 7:38.9 +30-18; 12, 7:30.7 +29-40.

Nausikaa, 192, 9.3. Dec. 24, 8:29.0 +28-17. Jan. 3, 8:19.0 +28-46; 13, 8:06.9 +29-06; 23, 7:54.4 +29-14. Feb. 2, 7:43.2 +29-06; 12, 7:34.6 +28-46.

Angelina, 64, 9.7. Jan. 23, 10:05.2 +11-28. Feb. 2, 9:57.9 +12-00; 12, 9:49.2 +12-39; 22, 9:40.1 +13-18. Mar. 4, 9:32.1 +13-52; 14, 9:26.2 +14-15.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1953.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

NOTE: A copy of the sheet entitled "Bright Minor Planets for 1953," from which the above data have been taken, is available to anyone who sends the Cincinnati Observatory, Cincinnati 8, Ohio, a self-addressed stamped envelope.

OCCULTATION PREDICTIONS

January 23-24 **q Tauri** 4.4, 3:42.4 +24-19.3, 9, Im: **D** 7:22.6 +0.2 −1.3 94; **E** 7:31.5 +0.3 −1.9 118; **G** 7:06.2 −0.5 −2.1 109; **I** 7:03.5 −0.7 −2.7 120.

January 23-24 **18 Tauri** 5.6, 3:42.4 +24-41.6, 9, Im: **E** 7:45.7 −1.3 +1.9 20; **F** 7:38.1 −0.4 −0.4 68; **H** 7:18.0 −1.2 −0.7 78; **I** 7:15.9 −1.5 +1.6 28.

January 23-24 **21 Tauri** 5.8, 3:43.1 +24-24.6, 9, Im: **E** 7:46.3 +0.2 −1.4 100; **F** 8:06.4 +0.9 −2.8 140; **G** 7:25.1 −0.6 −1.6 93; **I** 7:21.6 −0.7 −1.9 104.

January 23-24 **22 Tauri** 6.5, 3:43.2 +24-23.0, 9, Im: **E** 7:50.5 +0.3 −1.5 106; **G** 7:29.6 −0.5 −1.8 99; **I** 7:27.2 −0.7 −2.2 111.

January 23-24 **20 Tauri** 4.0, 3:43.0 +24-13.3, 9, Im: **G** 7:36.0 +0.2 −4.0 143.

January 23-24 **BD +24°562** 6.7, 3:44.2 +24-22.6, 9, Im: **G** 7:57.4 −0.2 −2.0 106; **I** 7:57.7 −0.4 −2.5 119.

January 26-27 **Epsilon Geminorum** 3.2, 6:41.0 +25-10.8, 12, Im: **G** 11:47.8 +0.3 −1.9 125; **H** 12:23.0 +1.1 −2.7 163; **I** 11:53.2 +0.3 −2.1 137. Em: **G** 12:40.1 +0.2 −1.3 265; **I** 12:42.5 −0.1 −1.2 255.

January 29-30 **BD +17°1966** 6.8, 8:50.6 +17-32.9, 14, Em: **A** 23:31.8 −0.2 +1.2 276; **B** 23:34.4 −0.3 +0.9 289; **C** 23:26.8 0.0 +1.3 270; **D** 23:31.5 −0.1 +0.9 287.

January 29-30 **X Cancri** 6.5 (var.), 8:52.7 +17-24.7, 14, Im: **A** 23:37.6 −0.3 +0.8 111; **B** 23:40.2 −0.3 +1.1 101; **C** 23:34.2 −0.3 +0.4 119; **D** 23:37.0 −0.1 +1.0 102. Em: **A** 0:45.0 −0.8 +0.9 284; **B** 0:46.6 −0.8 +0.6 294; **C** 0:38.0 −0.6 +1.3 273; **D** 0:41.3 −0.6 +0.8 290; **E** 0:33.8 −0.2 +0.8 286.

January 29-30 **BD +17°1979** 6.3, 8:54.5 +17-19.6, 14, Im: **A** 0:35.3 −0.7 +1.0 101; **B** 0:38.4 −0.6 +1.5 90; **C** 0:29.4 −0.6 +0.6 112; **D** 0:32.9 −0.4 +1.4 94; **E** 0:25.6 −0.1 +1.1 98. Em: **E** 1:29.8 −0.6 +0.5 294; **F** 1:18.9 −0.2 +1.2 267.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +31°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0

I +123°.1, +49°.5

SKY-GAZERS EXCHANGE

Classified advertising costs 10 cents a word, including address; minimum charge $2.50 per ad. ***Remittance must accompany order.*** **Insertion is guaranteed only on copy received by the first of the month preceding month of issue; otherwise, insertion will be made in next available issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for any statements made in the classified column, nor for the quality of merchandise advertised. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.**

Here and There with Amateurs

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ARIZONA	Phoenix	*Phoenix Obs. Ass'n.	8:00, 1st, 3rd, Tue.	Phoenix College	Paul E. Griffin, 1708 S. 3rd St.
CALIFORNIA	Fresno	Central Val. A.S.	7:45, 2nd Mon.	Fresno Coll., Homes	Mrs. Virginia Byrd, 409 Shields Ave.
	Kentfield	*Marin Am. Ast.	8:00, 4th Fri.	Marin College	Mrs. I. Osborn, 223 Santa Margarita, San Rafael
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club	7:30, Last Fri.	Private homes	C. M. Bell, Jr., 5319 Brittain, Long Beach 8
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	Miss A. Roemer, 1556 Everett, Alameda
	Palo Alto	*Peninsula A.S.	7:30, 1st Fri.	Community Center	H. W. Milner, 350 Tennyson Ave.
	Sacramento	*Sac. Val. A.S.	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Wed.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, Bayview 3757
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton College, P-11	C. D. Corwin, 1427 N. Center St. (3)
COLORADO	Denver	†*Denver A.S.	8:00, 2nd, 4th Mon.	Chamberlin Obs.	Kenneth Steinmetz, 4282 Grove, GR 9143
CONNECTICUT	Middletown	*Centr. Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	Walter Fellows, Middle Haddam
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	320 York St.	Mrs. Helen Velardi, 437 Wash., N'th Haven
	Norwalk	Perkin-Elmer AA&TM	5:00, 1st, 3rd, Wed.	Perkin-Elmer plant	J. Vrabel, Bob White Lane, Wilton
	So. Norwalk	Fairfield Co. A.S.	8:00, Alt. Fri.	Private homes	Goldie L. Grantham, 58 Bouton St.
	Stamford	Stam. Museum A.A.	8:00, 3rd Fri.	Stamford Museum	R. F. Ives, Post Rd. East, Darien
DIST. COL.	Washington	†Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Mrs.G.R.Wright,202PipingRk.Dr.,Silv.Spr.,Md.
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	†*J.A.A.C.	8:00, 1st, 3rd, Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†Key West A.C.	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	†*South'n Cross A.S.	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
	Miami Springs	†*Gulfstream A.A.	8:00, 4th Fri.	Armory, U. of Miami	L. G. Pardue, 641 Falcon, 88-5434
GEORGIA	Atlanta	†*Atlanta A.C.	7:30, 2nd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
ILLINOIS	Chicago	†*Burnham A.S.	4:00, 2nd Sun.	Adler Planetarium	Wm. Callum, 1435 Winona St.
	Geneva	*Fox Valley A.S.	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 420 Fellows St.
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	†*Indiana A.S.	2:15, 1st Sun.	Riley Library	Clark B. Hicks, 305 Ruckle St.
	South Bend	St. Jos. Valley Ast.	8:00, 1st Mon.	Hotel La Salle	Miss I. DeBruycker, 1023 S. Union, Mishawaka
KANSAS	Wichita	†*Wichita A.S.	8:00, 1st Wed.	214 East High Sch.	S. S. Whitehead, 2322 E. Douglas, 62-6642
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 207 Sage Rd. (7)
LOUISIANA	New Orleans	A.S. of N.O.	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†A.S. of Maine	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:00, 1st Thu.	Harvard Obs.	Dr. Dorrit Hoffleit, Harvard Observatory
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	John Patterson, 142 Elgin, Newton Centre 59
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	J. E. Welch, 107 Low'r B'verly Hills, W. S'field
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	W. C. Lovell, 24 Courtland (2), 3-1559
MICHIGAN	Ann Arbor	†Ann Arbor A.A.A.	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†B. C. Ast. Club	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†*Detroit A.S.	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†*Lansing A.A.	8:00, Fri.	Private homes	Edward H. Carlson, 2111 Grant St. (10)
	Pontiac	†*Pon.-N.W. Det. A.A.	3:00, 3rd Sun.	Cranbrook Inst.	G. Carhart, 40 Hadsell Dr., FE 2-9980
MINNESOTA	Duluth	*Darling A.C.	8:00, 1st, 3rd Fri.	Darling Obs.	Mrs. A. Lynch, 1911 Wisconsin, Superior, Wis.
	Minneapolis	M'polis A.C.	7:30, 1st, 3rd Wed.	Public Library	Jane Simmer, 2406 Clinton Ave. S.
	St. Paul	†*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. R. E. English, 1283 Sargent Av.
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, 3rd Sat.	Morrison Obs.	R. C. Maag, 816½ S. Mass., Sedalia
	Kansas City	†*A.A. & T.M.s	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd or 4th Fri.	Inst. of Tech., St. L. U.	S. O'Byrne, 501 E. Pacific, Webster Groves 19
NEVADA	Reno	A.S. of Nev.	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Caldwell	West Essex A.A.	8:00, 2nd Mon.	Caldwell Mun. Bldg.	D. C. Smith, 19 Francisco Ave., W. Caldwell
	Jersey City	†Revere Boys Club	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Roselle Park	†A.A.S. of Union Co.	....., 4th Fri.	Boro Hall	Mrs. R. N. Bochau, 236 Normandy Vill., Union
	Rutherford	A.S. of Rutherford	8:00, 1st Thu.	YMCA	W. B. Savary, 78 W. Pierrepont Ave.
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW MEXICO	Las Cruces	†*A.S. of L.C.	....., 1st Sat.	Private homes	C. W. Tombaugh, 636 S. Alameda
NEW YORK	Buffalo	†*Buffalo A.A.	7:30, 1st Wed.	Mus. of Science	Dr. F. S. Jones, 83 Briarcliffe, Cheektowaga (25)
	Gloversville	†*A.C. of Fulton Co.	....., ...	....	L. R. Ogden, 60 W. Pine St.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., TR 3-1300
	New York	†Junior A.C.	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., TR 3-1300
	Rochester	†Rochester A.C.	8:00, Alt. Fri.	Rochester Museum	Peggy Lagen, 34 S. Goodman St. (7)
	Schenectady	†*S'tady A.C.	7:30, 3rd Mon.	Nott Terrace H.S.	C. E. Johnson, 102 State St.
	Troy	*Renss. Ap. Soc.	7:30, Alt. Tue.	Sage Lab., R.P.I.	Dr. Robert Fleischer, R.P.I.
	Utica	†*Utica A.A.S.	7:30, 4th Tue.	Proctor Inst.	John Zimm, 239 Thieme Pl.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†*Greensboro A.C.	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Z. V. Conyers, 210 W. Fisher Ave.
	Raleigh	†Astronomical Soc.	....., 1st, 3rd Thu.	N. C. State Coll.	Richard C. Davis, Sch. of Textiles
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Akron	*A.C. of Akron	8:00, 2nd Fri.	Beth.-Luth. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	Robert Berkmeier, 2432 Ohio Ave.
	Cincinnati	*Cin. A.S.	8:00, 3rd Wed.	5556 Raceview Ave.	John Dann, 3318 Felicity Dr. (11)
	Cleveland	†Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. A. Townhill, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	7:30, 3rd Sat.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, RR 7, Box 253A (9)
	Lorain-Elyria	*Black River A.S.	7:30, 2nd Tue.	Lorain YMCA	Louis Rick, Box 231, Lorain
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	....., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OKLAHOMA	Tulsa	†*Tulsa A.S.	7:30, 1st Sat.	Private homes	Roy N. O'Mara, 1112 N. Braden
OREGON	Portland	†*Portland A.S.	8:00, 1st Mon.	Planetarium	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Mus. of Sci. and Ind.	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Millvale	A.A.A. Shaler T'ship	8:00, 3rd Fri.	Cherry City Fire House	Cliff Raible, Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, LO 4-3600
	Philadelphia	†*Rittenhouse A.S.	8:00, 2nd Fri.	Franklin Institute	John Streeter, LO 4-3600
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	D. F. Mathe, 105 Beedle Circle (27)
RHODE ISLAND	Providence	Skyscrapers, Inc.	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., Jackson 1-5680
TENNESSEE	Chattanooga	†*Barnard A.S.	8:00, 3rd Fri.	Jones Observatory	C. T. Jones, 1102 James Bldg., 7-1936
	Nashville	*Barnard A.S.	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, U6-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Fri.	Texas Christian U.	A. W. Mount, 4326 Birchman
	Port Arthur	†*Port Arthur A.C.	7:30, 2nd Thu.	5228 Fifth St.	F. T. Newton, 5213 Fifth St., 2-4807
UTAH	Salt Lake City	†*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	†Springfield T.M.s	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†*Norfolk A.S.	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	Builders Exchange	Miss L. Sievers, 4018 Clinton Ave. (27)
WASHINGTON	Seattle	Seattle A.A.S.	8:00, 2nd Fri.	Rainier Field House	F. J. Ritscher, 1631 N. 53 St.
	Spokane	†*A.T.M.s of Spokane	8:00, Last Fri.	Private homes	Chet Brown, W. 1117-14th
	Tacoma	Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Beloit	†Beloit A.S.	....., 1st, 3rd Thu.	YMCA Bldg.	Kenneth W. Schultz, 959 Johnson St.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis

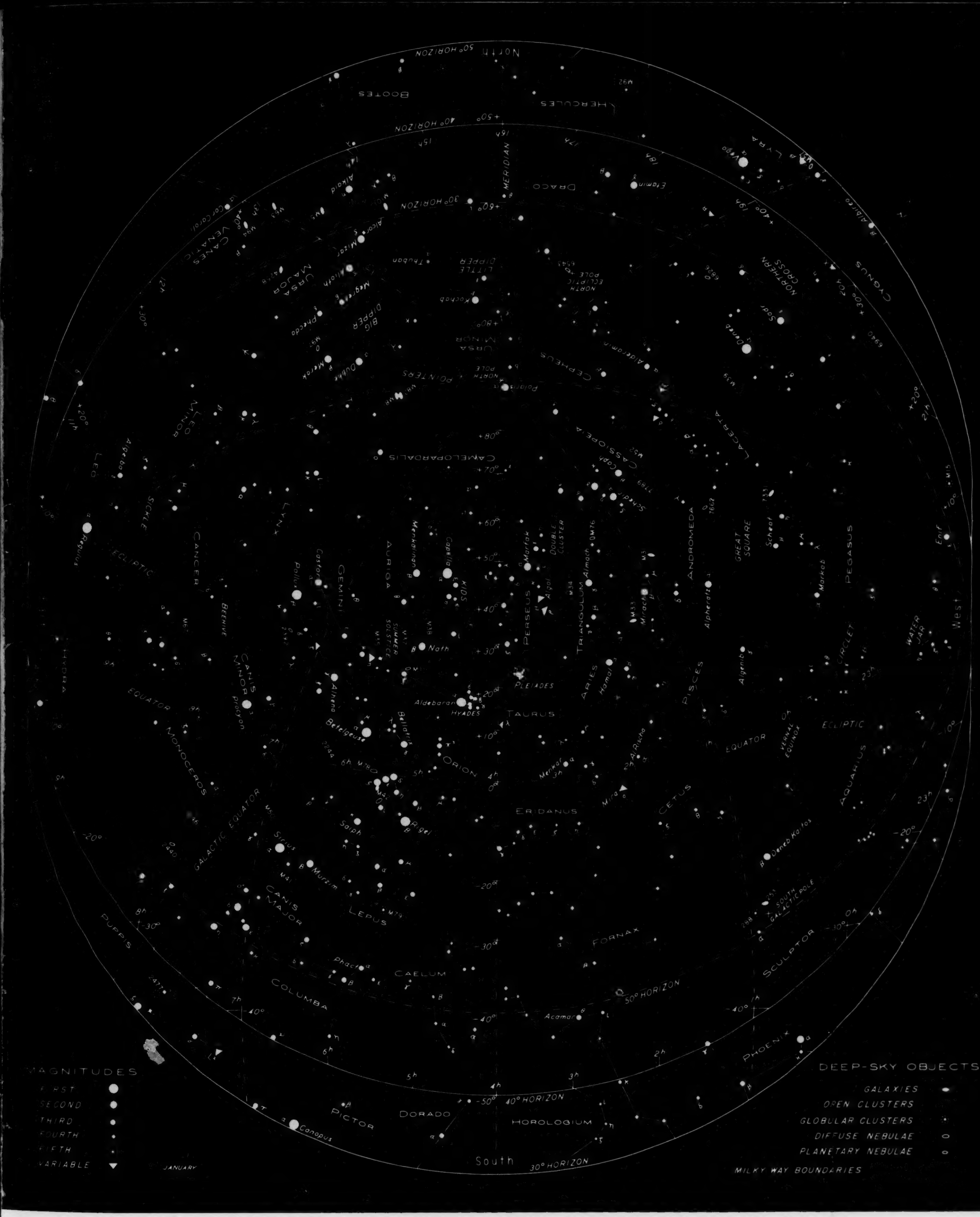
The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of April, respectively.

SOUTHERN STARS

MANY CONSTELLATIONS of great fame lie in the northern half of the sky as seen from southern latitudes during the fall season. And some of these are pretty much upside down when the mythological characters they are supposed to represent are pictured among their stars. We may imagine that such lengthy animals as Hydra have no top and bottom, but along the meridian to the north of Hydra both Leo and Ursa Major are very much on their backs, with the Hunting Dogs likewise in uncomfortable positions.

To the west, Orion and the Twins are on their sides, and the same can be said for Virgo, as she rises in the east. Bootes rises feet-first, and will cross the northern sky that way. Among many of the smaller groups, the orientation does not seem to matter much, as for Canis Minor, and such constellations as Canis Major are far enough south that they may be considered upright to most Southern Hemisphere observers.

Northern observers, however, may well envy the southerner's vantage point where such constellations as the Scorpion are concerned. That group is now rising in the southeast and will be a feature of the southern chart for the next seven months of the year.



STARS FOR JANUARY

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of January, respectively; also, at 7 p.m. and 6 p.m. on February 7th and 23rd. For other times, add or subtract ½ hour per week. When facing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.